INDUS, THE BLUE GOLD: RETHINKING THE TRANSBOUNDARY WATER DISTRIBUTION BETWEEN INDIA AND PAKISTAN

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Abstract: The Indus River and its five tributaries rising in the Himalayan Mountains in India flows through Pakistan and ultimately drains into the Arabian Sea. The water resource of these rivers aids in the generation of hydroelectricity, navigation and sustains the agriculture of India and Pakistan. Since the partition of India and Pakistan in 1947, there have been repeated conflicts regarding these transboundary rivers between the two nuclear powered nations due to faulty boundary planning and due to Chinese interference in the upstream Indus. Previous scholarship mostly focuses on the political debates of water sharing; few studies have focused on the effect of the water dispute on the agriculture of the countries. I will use GIS technology to map the changing patterns in agricultural activity and draw an analogy between the river's flow volume and speed with the temporal and spatial pattern of agricultural activity and power generation in the two riparian countries. Qualitative analysis involving personal interviews of the farmers cultivating in the Indus Basin and key informant interviews helped in understanding changing perceptions and real-life experience. Analysis of the research data shows disturbing displacement of village people due to dam constructions and misuse of the river water. This research will help in forming a deeper understanding of the water sharing issues persisting in one of the largest river systems and the largest irrigation canal system in the world. The unique methodology used will help in understanding the water problem from the common man's perspective and aid in policy formulation.

Key words: water politics, Indus, GIS

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CHAPTER I

INTRODUCTION

"If the wars of the twentieth century were fought over oil, the wars of this century will be fought over water." Ismail Serageldin, Vice President of World Bank (World Bank 1960).

"No armies with bombs and shellfire could devastate a land so thoroughly as Pakistan could be devastated by the simple expedient of India's permanently shutting off the source of waters that keep the fields and people of Pakistan green" David Lilienthal, 1951 (Ahmad 2011,73).

The Indus Valley Civilization, also known as the Harappan culture, was one the world's oldest urban civilizations, located along the banks of the Indus River Basin, in mainly present-day northwest India and Pakistan (see Figure 1). This was one of the four important civilizations of the Old World's primary civilizations. This civilization spread to the south, north, east and west of the Indus River Basin for over 500,000 square miles. This was an urban center sustained mostly by agricultural production and commerce. It had a population of about five million people and was the one of the largest human civilizations in history. The chief urban center Mohenjo-Daro was one of the main urban centers and archaeological marvels with a highly sophisticated and developed civil engineering and urban planning. At its zenith, the Indus Valley Civilization (Figure 1) spread over the entirety of north India and Pakistan and extended westwards up to the border of Iran (Kundu 2013). This civilization flourished in the same time span as the ancient Egyptian and Sumerian civilizations and even preceded the Chinese civilization. Carbon-14 dating has revealed its time span to be between 2175-1750 B.C. (Fitzsimons 1970). In order to understand the importance of the Indus River and its tributaries it is important to understand its historical importance and the glory of the ancient civilization that flourished on its banks.

Figure 1: Sites of Early Indus Valley Civilization

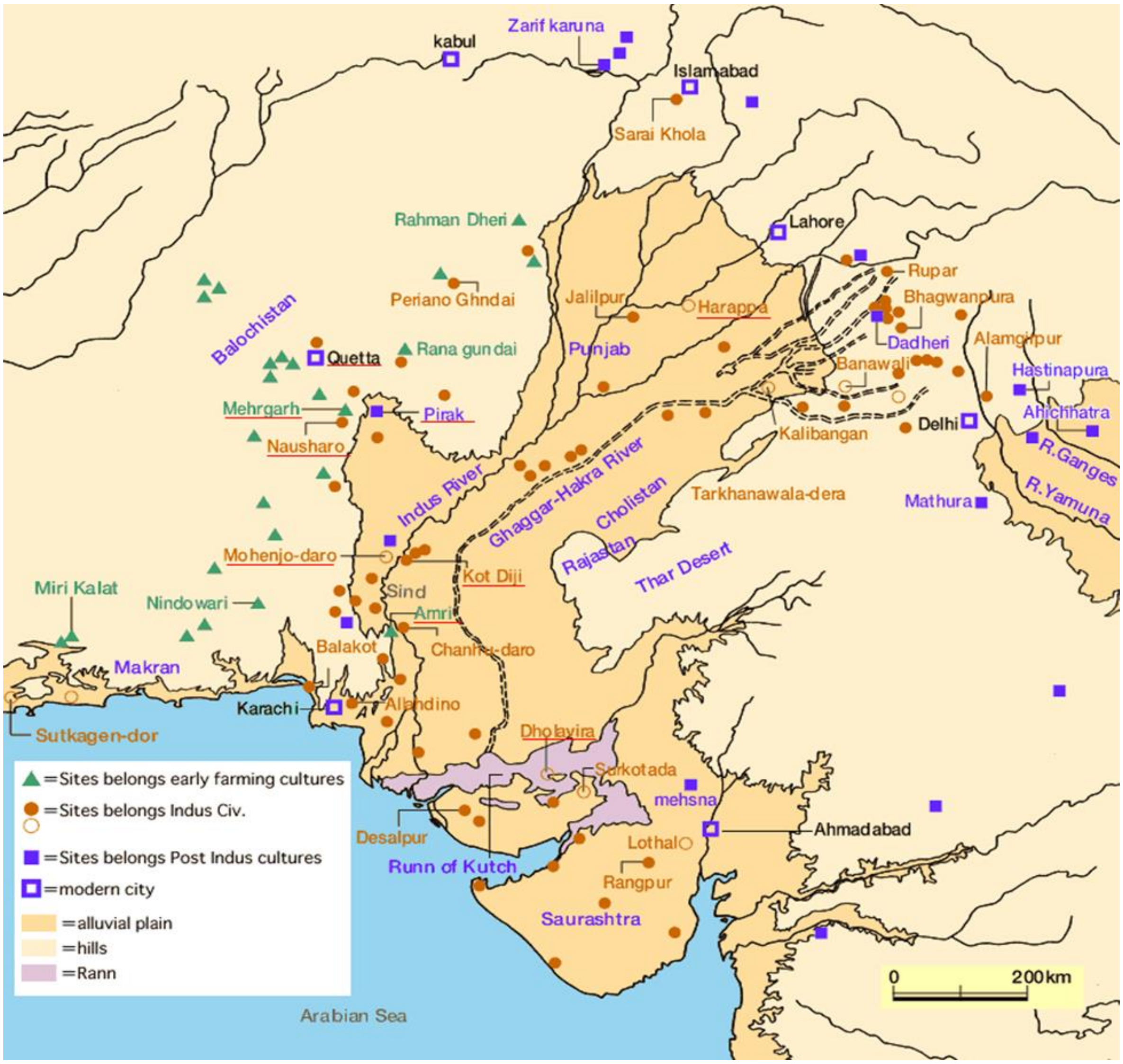


IMAGE SOURCE: https://www.crystalinks.com/induscivilization.html.

STUDY AREA

Fast forward to the 1900s-2000s; the significance of the Indus River and its tributaries have increased manifold. The Indus River System consists of six rivers, out of which the Indus River is the main river, originating in Lake Mansarovar in Tibet and flowing westwards through India and Pakistan and draining into the Arabian Sea. The other five rivers in the system—the Ravi, Beas, Sutlej, Jhelum, and Chenab are tributaries of the Indus River (Figure 2) and join the Indus at Mithankot, a city in Southern Punjab to form Panjanad (literally meaning five rivers). The *Indus River* is the longest river of both India and Pakistan. It originates in Western Tibet, in Lake Mansarovar in Mount Kailash, flows through the Ladakh region in India, Gilgit Baltistan, Khyber Pakhtunwala and Punjab in Pakistan and finally drains into the Arabian Sea near Thatta in Sindh. *River Ravi* originates in the Chamba District of the state of Himachal Pradesh in India and drains into the Chenab River as its tributary. The *Chenab River* also has its origins in the Lahul and Spity region in the state of Himachal Pradesh, passes through the Indian state of Jammu and Kashmir and drains into the Punjab region of Pakistan. *River Jhelum* originates in the south-eastern Kashmir valley in India, from the Verinag Spring located at the foothills of the Pir Panjal range. The *Sutlej River* originates in the Lake Rakshatal in Tibet. From here it flows through the state of Himachal Pradesh in India. It ultimately joins the River Beas in the state of Punjab in India. The *Beas River* has its origin in the Indian state of Himachal Pradesh and flows into the Sutlej River in Punjab (FAO Water 2010).

The study area under consideration in this research is the Indus River Valley, formed by the river Indus and its tributaries of Jhelum, Chenab, Sutlej, Ravi, and Beas. The Indus River Valley covers about 1.12 million km^2 covering the countries of China (8%), India (39%), Pakistan (47%) and Afghanistan (6%). The Indus Valley is home to about 300 million people and agriculture is the most important economic activity carried out here (FAO Water 2010). The Indus River Valley covers most of the country of Pakistan and supports the major part of the agriculture of Pakistan. About 42.3% of Pakistan's labor force is involved in agriculture, the highest proportion of labor in economic activity in the country (cia.gov 2015). India uses the waters of the Indus mostly for generating hydroelectricity and navigation.

Figure 2: Study Area-Extent of the Indus River in India and Pakistan

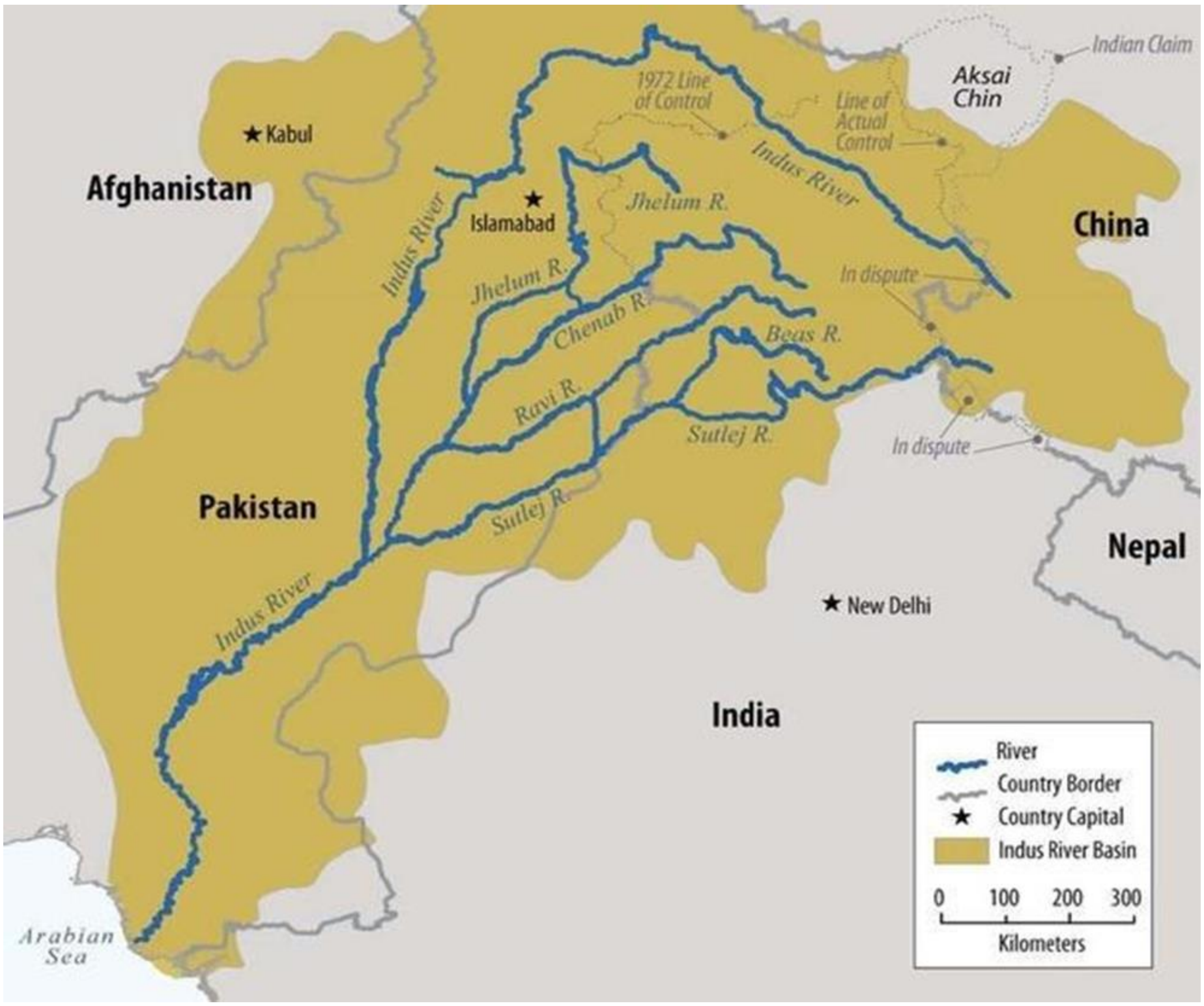


IMAGE SOURCE**:** https://qph.ec.quoracdn.net/main-qimg-d272f8700fef14fbbef696da13fcbc65-c

Disputes over shared water resources is one of the most common resource related disputes in the modern age. There might be a time in the near future, when water will become more expensive than oil. "In Australian supermarkets, a bottle of Mount Franklin Spring Water costs around $3.33 a litre. At the pumps in mid-February 2018, the average cost of a litre of unleaded petrol is less than half that, at $1.38"

(McCracken 2018, para 6). In this case, the context also matters. As Dr. Brian Cook, researching in Development Geography, in the University of Melbourne puts it, "… it is more complicated and less alarmist than that. Unlike petrol, clean drinking water is available from a drinking fountain or a tap, in some instances for free" (McCracken 2018).

"…In certain contexts, water is already more expensive than gas or petrol. It has to do with where you are, how much you are purchasing, and whether your country subsidizes that resource. And it depends how a country values that resource: is it a commodity or a right? Most countries seem to agree that water is a right, keeping it cheap or free to access" (McCracken 2018, para 8-10).

But the question here is how long are we going to have this free access to water? Water is a renewable and replenishable resource. However, the source of fresh water on the surface of the earth is limited; therefore, we need to use water in a sustainable manner. The problem of scarcity of water becomes further conflictive and political in nature when the water resource is in the form of a river or a water body shared between two or more states (also known as riparian countries). The differential views and problems with sharing this scarce resource often result in political, economic or social conflicts. A problem related with water sharing between these riparian countries is the distribution, allocation, and sharing of this scarce resource. This research focuses on one such exemplary water-related social, economic and political conflict ~ the Indus Water conflict between India and Pakistan. The importance of this water-related research lies in the fact that this water conflict led to one of the oldest and most successful water sharing agreements (Indus Water Treaty) in the world which has survived two wars and numerous terrorist attacks between the two countries.

Water has been one of the most important sources of conflict between India and Pakistan since the partition of the Indus Basin System in 1947. As a result of this partition, India gained control over the canal headworks as the Upper Riparian country. These canals were the ones that supplied water to vast agricultural areas of Pakistan, which had now become the lower riparian of the Indus system. After a long series of negotiations, and mediations brokered by the World Bank, the Indus Water Treaty (IWT) was signed by the two countries in 1960. The Indus Water Treaty divided the waters of the Indus Basin between India and Pakistan. According to the Indus Water Treaty, India had full control over the three Eastern Rivers—the Sutlej, the Ravi and the Beas. On the other hand, Pakistan had exclusive control on the Western Rivers—the Indus, the Jhelum and the Chenab (Akhtar 2010). However, even after the signing of the Indus Water Treaty, there have been constant disputes regarding the Indus waters. India started building a number of hydroelectric projects on the Western Rivers which rang alarm bells for the already water-insecure Pakistan. Pakistan started claiming that India is robbing Pakistan of its waters. There have been constant disputes between India and Pakistan, regarding the construction of hydroelectric power projects like the Salal Dam construction (1978), Wullar Barrage/Tulbul Navigation Project, Kishanganga hydroelectric dams, and so on (Akhtar 2010).

A bone of contention between the two countries of India and Pakistan is also the state of Jammu and Kashmir, which is occupied partly by India and Pakistan. One of the reasons why Pakistan demands the entire Kashmir is that it is the upper riparian area of the Indus basin. If Pakistan had authority over Jammu and Kashmir, then there would be no water problem for Pakistan. She would be in control of both the upper riparian and the lower riparian area of the Indus Basin. This would solve all the water problems for Pakistan, and being an agricultural economy, this would be a boon. Unlike India, Pakistan is not the land of numerous rivers and has not been gifted with a wealth of water resources (Kulz 1969; Gazdar 2005; Ahmad 2011).

This research will help in forming a deeper understanding of the water sharing issues persisting in one of the largest river systems in the world that has led to the formation of the largest irrigation canal system in the world. This research will help in forming a better understanding of the extent to which this treaty has guided the fate of the Indus River System and the hydropolitics between the two countries. Because these two are nuclear empowered countries and there is a risk of a war anytime over water, understanding the origins of this water conflict, the structure and functioning of the water sharing and the attitudes of the people of both countries is of paramount importance. This research is important, unique, and an original contribution for two reasons; the broad study area involved, and the techniques and methods used. Previous studies have mostly focused on the Indian side of the Indus River system, or the Pakistani side. Some researchers have narrowed down their focus to particular agricultural villages irrigated by the Indus, looking at how this area's agriculture has been affected by the water sharing statistics. Also, other researchers often concentrated on a single river of the Indus System and how it is used. I aim at working on the entire drainage area, starting from the source of the Indus and its tributaries to the Indus Valley in Pakistan (see Figure 2). My broad study area will allow me to conduct a comparative analysis of the repercussions and perceptions of the water conditions of the two countries and this will allow me to look at both the Indian and Pakistani side of the story simultaneously. This simultaneous observation of the two countries will be one of the unique contributions of my research.

THE PAST AND PRESENT OF THE INDUS PROBLEM

The length of the Indus River alone is 1800 miles. Together with the tributaries the Indus River system measures more than 2800 miles, thus making it one of the largest river networks in the world. The Indus basin lies in the states of Jammu and Kashmir, Himachal Pradesh, Haryana, Rajasthan and Punjab in India. In Pakistan, the basin mostly lies in Punjab, Sindh and the North-West Frontier Province (N.W.F.P). "According to the pre-1947 political subdivisions, the Indus basin in India comprised the British Provinces of the Punjab, N.W.F.P. and Sind; the then princely States of Jammu and Kashmir, Patiala, Nabha, Faridkot, Jind, Kapurthala, Bikaner, Bahawalpur, Jaisalmer, Khairpur, Bilaspur, Mandi, Chamba and several other small states in the Punjab hills, the North-West Frontier States and tribal areas, together with parts of the British Province of Baluchistan and of the Indian States of Jodhpur and Jaipur" (Gulhati 1973, 21).

Irrigation had been practiced in the Indus Basin since prehistoric times, but the most remarkable developments in terms of modern engineering took place only since the middle of the nineteenth century. Inundation canals (Figures 3 and 4) would serve the benefits of irrigation until about 1850, along areas of Jhelum, Panjnad, Sutlej and the lower Chenab, and the water in these canals depended on the levels of the annual river rise in summer (Gulhati 1973). Small irrigation channels, known as Kuhls, were present in the higher mountainous areas like the Kashmir Valley and on the Beas. Some of the first canals which were built were the Upper Bari Doab Canal in Punjab, completed in 1859. Figures 3 and 4 provide an outline of how the Indus River system irrigation network is organized. In Figure 4, we can see the entire array of irrigation canals, dams and barrages which control the flow of water in the Indus irrigation system in Pakistan. The outline provided in Figures 3 and 4 helps in forming a clear understanding of the way in which the Indus water flow is managed in Pakistan.

Figure 3: Indus Basin Irrigation System

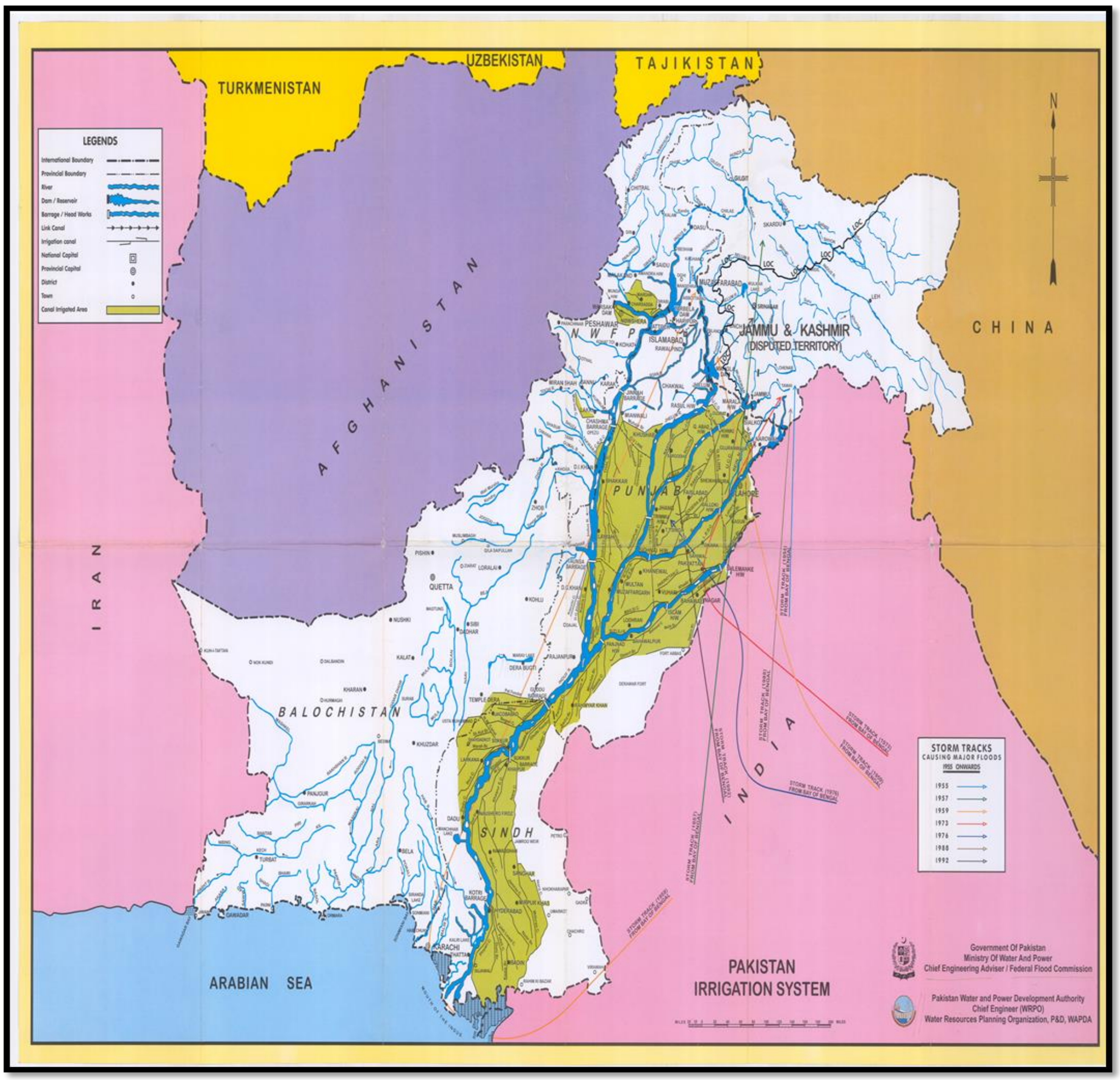


IMAGE SOURCE: WAPDA, http://www.wapda.gov.pk/index.php/projects/system-irrigation

Figure 4: Indus Basin Irrigation Network

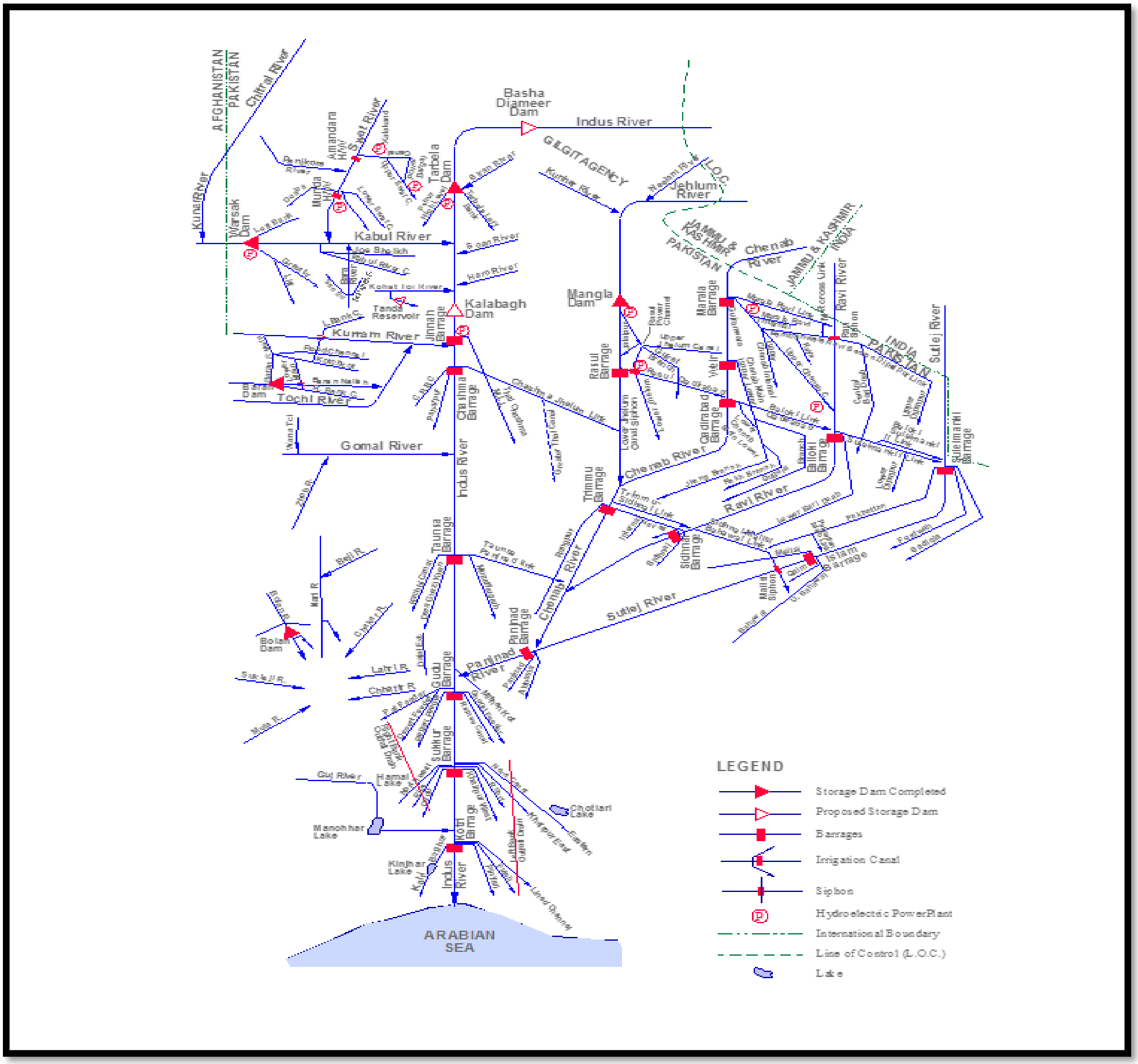


IMAGE SOURCE: WAPDA, http://www.wapda.gov.pk/index.php/projects/indus-irrigation-system

Prior to the Indus water disputes between India and Pakistan, there had been inter-state water disputes and rivalries before the political partition in 1947. The Indus water dispute can therefore be divided into two phases, "… prior to 1947, mainly between the British Provinces and Indian States and, since 1947, between different Indian States and between India and neighboring countries" (Gulhati 1973, 36). Some of the new irrigation projects developed in the Indus Basin after the First World War were the Sutlej Valley Project (completed in 1932 and comprising of nine canals and three headworks on the Sutlej River), the Sukkur Barrage Project (comprising of a barrage and seven canals coming off this barrage across the Indus at Sukkur) and the Bhakra Project (on the Sutlej River at Bhakra for the irrigation of Bikaner state and south-east Punjab), (Gulhati 1973).

> It was at this time that, for the first time, questions were raised about canals in the upper reaches of the rivers affecting adversely the scope of projects lower down the system. Inter-State rivalries began to assert themselves, mainly between the British Provinces of Punjab and Bombay (Sind was a part of Bombay until 1935) though the Indian States of Bahawalpur and Bikaner were also involved. After considerable discussion between the Government of India, the Secretary of State for India in London and the State Governments concerned, the Sutlej Valley Project and the Sukkur Barrage Project were sanctioned for execution (Gulhati 1973, 36-37).

Some of the other projects like the Thal Canal and the Haveli Canals had their sanctions withheld until more reliable data were examined about river supplies that had been collected over the years. To tackle the problems that arose with regards to the new canals, the Government of India appointed the Anderson Committee (a committee consisting of eight experts) in 1935. This committee, "… was able to secure full agreement of all parties and its unanimous recommendations were approved by the Government of India in 1937. Increased withdrawals were approved for some of the canals; some reduction was made in others" (Gulhati 1973, 37).

The political partition of India and Pakistan disrupted the developing irrigation system of the Indus. There were about 26 million acres of established irrigated agriculture and several million acres of arid lands were still waiting to be irrigated and developed from these rivers. The Indus Basin, a contiguous irrigated land, was thus divided between two sovereign states. The state of Punjab in India was divided into East Punjab under India and West Punjab under Pakistan. At the beginning the problem of water supplies to the existing canals was relatively simple. The majority of the larger canals lay entirely in Pakistan, while a few of the other large ones lay entirely in India. However, there were two canals which were jeopardized with the partition—the U.B.D.C. Canal and the Dibalpur Canal. The U.B.D.C (later known as C.B.D.C.) which lay in West Punjab in Pakistan, after partition had to receive water from the upper channels in East Punjab. The Dibalpur Canal had its water from a barrage in east Punjab. The real problem for India was that, out of the 26 million acres of irrigated land, the Partition placed about 21 million acres in Pakistan, and the remaining 5 million acres in India. The partition of the two countries happened at a time when the most profitable development schemes and new technology had already been implemented and many areas lying distant from the rivers were still awaiting development. In short, the part of the Indus River Plain that came to India was much less developed (Fowler 1950; Gulhati 1973).

> The newly imposed political frontier not only disrupted the food supply line for the 21 million people in India, but also severed suddenly the hydrologic unity of the river system and posed a serious obstacle to the development of several million acres of highly arid, but otherwise fertile, land in the Indian part of the Indus Basin, which was awaiting development and had no source of water supply to rely upon other than the Indus Rivers. The migration to India of a large population from the canal irrigated areas of West Punjab and Bahawalpur only added to the seriousness of the problem and called for urgent action (Gulhati 1973, 59).

West Punjab did not take any steps until 31st March 1948 (when the earlier water settlement regarding these canals expired) to ensure continuous supply of water to the C.B.D.C and Dibalpur Canal from the installations which lie in East Punjab. On 1st April 1948, East Punjab in India discontinued the use of its installations, which were being used for the benefit of C.B.D.C. As a result, some of the irrigation channels lying near Lahore became dry. The discontinuation of the installations made West Punjab and Pakistan paranoid, they saw it as a signal of danger. Even though a mutually temporary satisfying agreement was reached between the two, Pakistan had already become suspicious of India's intentions about the Indus Rivers.

> The headwaters of all these rivers were in India, or in territory not subject to Pakistan, and the consequences of possible aggressive intentions on India's part soon loomed large before Pakistan. Not only West Punjab but Bahawalpur and Sind were also seriously concerned. The cry was raised, 'Pakistan might return to the desert'. A declaration by the Prime Minister of India that he would not build the prosperity of India on the misery of the Pakistan cultivators made no impression on Government circles in Pakistan" (Gulhati 1973, 60).

For India, the basic concern was to expand the irrigated agricultural area from five million acres to as much as it could expand. On the other hand, the main concern for Pakistan was that this ambition of India does not harm Pakistan's existing 21 million acres of irrigated agriculture. Pakistan was also tackling the issues of salinity in the agricultural farms (Gulhati 1973).

A major problem that came into existence due to the partition involved the waters of the Sutlej and the Ravi Rivers. India received ownership of the entire upper course of Sutlej and also the entire course of the River Beas. As a result of the partition it also gained control over the Ferozepur headworks on the River Sutlej and the Madhopur headworks situated on the River Rabi. Both of these canals served water to canals in Pakistan. Further, India's occupation of the Vale of Kashmir gave her control over the waters of the Jhelum River and control over Ladakh gave India complete control over the Indus head reaches. It was not until Pakistan occupied Azad Kashmir and Gilgit that Pakistan secured the most important part of the Jhelum River that leads to the Mangla headworks and the remainder of the course of the Indus (Michel 1967).

On the 1st of April, when West Punjab stopped the waters to East Punjab, marked an important date in the 'Canal Waters Dispute'. On 3rd May 1948, a conference was arranged at New Delhi, and under the Prime Minister's orders, the water supplies to the C.B.D.C. were resumed by East Punjab and the Dibalpur Canal was also opened. Pakistan used this incident as an opportunity to garner support from the international arena for its situation. Then on 13th June 1949, Pakistan, in an urgent telegram to India, communicated that it required an equitable share of the common waters between India and Pakistan. After a series of communications back and forth, India told Pakistan on 18th September 1951, that if she had any doubts regarding the agreement of May 1948, she is free to take the matter to an impartial international authority (Fowler 1950; Gulhati 1973).

David E. Lilienthal, the former Chairman of the Atomic Energy Commission and the Tennessee Valley Authority, visited India and Pakistan. In both India and Pakistan, Lillienthal met the Prime Ministers of the two countries, Jawaharlal Nehru and Liaquat Ali Khan respectively. He discussed the economic warfare between India and Pakistan, river issues, and the question of Jammu and Kashmir. He wrote two articles about his visit to India and Pakistan and the Indo-Pak relations. In one of these articles, he made a proposal about solving the Indus water dispute as follows: -

> India and Pakistan were on the verge of war over Kashmir. There seemed to be no possibility of negotiating this issue until tensions abated. One way to reduce hostility, I wrote, would be to concentrate on other important issues where cooperation was possible. Progress in other areas would promote a sense of community between the two nations which might, in time, lead to a Kashmir settlement. Accordingly, I proposed that India and Pakistan work out a program jointly to develop and jointly operate the Indus Basin river system, upon which both nations were dependent for irrigation water. With new dams and irrigation canals, the Indus and its tributaries could be made to yield the additional water each country needed for increased food production (Gulhati 1973, 93-94).

Lilienthal was then contacted by Eugene R. Black, the then President of the World Bank, who believed that Lilienthal's proposal was good and might actually help in solving the problems between the two countries. The World Bank took interest in the Indus water dispute and in September 1951, Black sent a letter to the Prime Ministers of Pakistan and India offering the World Bank's help to solve the Indus water dispute. The World Bank was worried that if the dispute continued it would seriously affect the economies of both countries. After a series of meetings and rejection of proposals, the Indus Water Treaty was finally signed on 19th September 1960 (Gulhati 1973).

While discussing the Indus problem and how the water is shared between India and Pakistan, another important topic that needs to be addressed is the constant issue with the state of Kashmir and how these issues came into existence.

THE STATE OF KASHMIR

The political problem between India and Pakistan has a lot to do with the concept of identity derived from a shared community. "In Pakistan, this bond involves the shared religion of Islam and the sentiments regarding the distribution of land in Kashmir. That the conflict is persistent is no secret, it has been prolonged, with four wars fought from the beginning until now" (Vaish 2011, 53). There have been four wars between India and Pakistan in 1947, 1965, 1971 and 1999, together with numerous attacks. One of the reasons Pakistan wants Kashmir, and India resists it, other than the shared identity, is the flowing of all the Indus Rivers through Jammu and Kashmir. If Pakistan is able to capture Kashmir, then it does not need to worry about the Indus River and its tributaries as it will have access and ownership to the headwaters of the Indus (Vaish 2011).

The Jammu and Kashmir situation complicated the entire water situation after partition, by giving India great control over the Chenab and Jhelum Rivers. These rivers are not an important source of irrigation either for India or for Jammu and Kashmir. However, the entire West Punjab and West Pakistan depends heavily on these rivers (Michel 1967).

> When the Indus Waters Treaty was signed, hopes were expressed that a Kashmir settlement might soon be reached in the new climate of cooperation. Such hopes unfortunately proved unfounded, basically because of the essential difference between the two disputes. In agreeing to recognize Pakistan's right in perpetuity to virtually all of the waters of the three western rivers (Indus, Jhelum, and Chenab), India was really giving away only one stream, the Chenab, that she could really use herself (by diversion into the Ravi or Beas). She was gaining undisputed possession of the waters of the three eastern rivers (Ravi, Beas, and Sutlej) in perpetuity after the Transition Period ends in 1970 or the latest in 1973. These are the rivers that are really useful to India, and the Indus Water Treaty gives her the right to dry them up entirely if she chooses (Michel 1967, 8).

The Indus Water Treaty deals only with water, and great care was taken to avoid sanctioning either India or Pakistan's claim to Jammu and Kashmir or any portion of it (Michel 1967). It was only in mid-1951 that the Indus waters were linked to the Kashmir dispute for the first time. "It was asserted that if Kashmir remained with India, Pakistan would run the risk of its canals being deprived of their water supply from the Indus, the Jhelum and the Chenab all of which flow from Kashmir to Pakistan" (Gulhati 1973, 313). "The political differences between the two countries on the status of Kashmir remained an important element in the negotiations-several stalemates were encountered on that account, attempts at brinksmanship were witnesses; fortunately, realism and pragmatism ultimately gained over sentimentalism and psychology and the treaty was written studiedly bypassing the Kashmir issue" (Gulhati 1973, 313).

While numerous discussions and research goes on regarding the Indus water treaty and the plight of the two countries of India and Pakistan, very little importance is given to the state of Kashmir. Although all the rivers flow through the state of Kashmir, very little importance is given to the condition of the people and the environment in Kashmir. To understand the grievances of Kashmiri people against the Indian government, it is important to understand the history of annexation of Kashmir to India, and the numerous failed promises which the Indian Government has made to the Kashmiris.

Although there have been several studies of the four wars between India and Pakistan, very few discuss exactly the origins and the root causes of these wars. According to Vaish (2011), the origin of the India-Pakistan conflict can be divided into three distinct factors that depict profound historical and social factors and forces that are still influential in the relations between India and Pakistan. The forces are as follows:

1. “The nature of British colonial and disengagement policy;
2. The ideological commitments of the leaderships of India and Pakistan; and lastly,
3. The strength of the irredentist/anti-irredentist relationship between the two countries” (Vaish 2011, 55).

The British (who ruled India for almost 200 years) were worried that they would not be able to maintain proper law and order as the All India Congress and the Muslim League, the two dominant political parties of pre-partition India, almost reached a political impasse related to the issues of transfer of power after partition. Hence the British decided on a shock therapy. In 1947, Clement Atlee, the then Prime Minister of the United Kingdom, announced in February 1947, that the British raj in India would end their rule in India in June 1948, irrespective of whether any decisions on the future political arrangements were reached or not (Vaish 2011).

Thereafter Lord Wavell was replaced by Lord Mountbatten (a cousin of King George VI) as the next viceroy of India. Lord Mountbatten was not keen on taking up the position in the first place, because he wanted to resume his career in the British Navy. Lord Mountbatten’s hastiness combined with Atlee’s announcement of a specific date, “… raised the possibility of an abrupt and hence inevitably disastrous disengagement of British power from the simmering volcano that was the Indian subcontinent” (Vaish 2011, 56). Mountbatten knew partition was inevitable, so he concluded that the date for partition should be advanced by almost a year to August 1947. “Mountbatten’s proposal for partition of the country into two and the subsequent transfer of power, though hastily drawn, was accepted by the Congress and the Muslim League as the only alternative to civil war” (Vaish 2011, 56). This meant that the British had only three months to divide the Indian Empire into two states.

“This mammoth task involved splitting the major functions of the country, including the division of Punjab and Bengal provinces, dividing financial and other national assets, dividing the Army, Navy and Air-Force, deciding how to divide the Indus River irrigation system, resolving the fate of the princely states that comprised one third of British India, and fixing the final boundaries of India and Pakistan. As can be expected, this haste to leave rendered the transitional process a complete disorder. It caused a mass exodus of over 15 million people from their homes in fear of unfavorable treatment from a government with a different religious ideology and sparked a dispute over Kashmir that remains unresolved even today” (Vaish 2011, 56).

The Hindu-Muslim riots which occurred as a result of the partition can be attributed to the hasty departure of the British which led to inadequate government arrangements to transport such huge numbers of people across the border. Also, the boundaries of the newly formed states of India and Pakistan did not align, “… with the natural distributions of the social, economic, linguistic, and cultural traits of the human population.

Hence an array of different cultural groups found themselves in different countries as ‘minorities’” (Vaish 2011, 57). India’s rejection of the idea of using religion as a basis for state building and Pakistan’s commitment to Islam is the root cause of several political tensions. Therefore, Pakistan feels the need to assimilate Kashmir which has a predominantly Muslim population in order to help Muslims develop a distinct and separate cultural ethos (Vaish 2011). In the pre-partition era, the Muslim League believed that incorporating all the Muslim-dominated parts of India and creating the theocratic state of Pakistan would ensure freedom from Hindu-dominated India and help in achieving completeness. On the other hand, it was also important for India to retain Kashmir and the Muslims to demonstrate secularism, and not to show that religion is the basis for the creation of a state. Without Kashmir, India would be a predominantly Hindu state (Vaish 2011). Kashmir was originally a princely state. The separation of the British Empire into India and Pakistan meant that the accession of the princely states to the two newly formed countries had to be resolved. Lord Mountbatten in his address on July 25, 1947, made it clear that the three princely states would need to join either India or Pakistan. All the princely states joined either of the two countries except those of Hyderabad, Junagarh and Kashmir. The last ruler of Kashmir as a princely state was a Hindu named Maharaja Hari Singh and ran a puppet monarchy. The dichotomy of having a huge Muslim population in Kashmir, a contiguous border with Kashmir, and ruled by a Hindu ruler made Pakistan all the more adamant to incorporate Kashmir into Pakistan. The way India forced Junagarh and Hyderabad to accede to India shaped Pakistan's plan of action towards Kashmir. Pakistani tribesmen attacked the capital of Kashmir, Srinagar (Vaish 2011). India had invaded Junagarh (having a predominantly Hindu population) and annexed it, in spite of the ruler's resistance. The news of Kashmir's invasion reached the Indian Government on October 25th. The ruler of Kashmir, Maharaja Hari Singh, appealed to the Government of India to fight the Kashmiri invaders. The Indian Government agreed to help the Kashmiri ruler on the condition that Kashmir would immediately accede to India. The ruler promptly acceded to India and within 24 hours India air-lifted troops into Pakistan and thus set the stage for the first war between India and Pakistan. Apart from the four wars there were several bilateral negotiations between the two countries from 1953-1956 and from 1960-64 (Vaish 2011).

Between 1953-1956 there were several bilateral discussions between India and Pakistan regarding Kashmir, with occasional involvement of the U.N. Security Council. In a meeting in New Delhi, both parties agreed in 1953, "…that the dispute would be settled without force and with the help of a plebiscite to ascertain the wishes of the people" (Vaish 2011, 62). However, Pakistan's joining the SEATO in 1954 and also signing the Baghdad Pact in 1955 had massive impacts on the politics of the Indian subcontinent and left the question of plebiscite for Kashmir in the background. By being an ally to the USA, Pakistan brought the cold war into the Indian subcontinent. On the other hand, India gained the support of the Soviet Union on the issue of Kashmir. The Kashmir issue was brought up to the U.N. Security Council by Pakistan in January 1957, because the bilateral negotiations were not yielding the desired results and also in the hope that it would get the full support of U.S. The United Nations Security Council suggested that it would send a temporary peace-keeping troop to Kashmir, which Pakistan agreed to. However, India would not allow foreign troops on what was essentially its land (Vaish 2011).

"The Security Council passed an amended resolution giving five recommendations: (1) creating an atmosphere favourable to negotiations, (2) reaffirming the integrity of the cease-fire line, (3) withdrawal of Indian troops from Kashmir, (4) interpreting the terms of a plebiscite, and (5) a meeting of the two prime ministers. India objected, such a proposal would be equivalent to saying that Pakistan had honored its commitments and not occupied Indian territory illegally" (Vaish 2011, 63). Even amidst all these negotiations and discussions the Indus Water Treaty was signed between India and Pakistan in 1960. Between 1960-64, Pakistan and India returned to the negotiating table again to discuss the Kashmir issue and there were about six rounds of talks with no concrete solution. There have been numerous attacks between the countries, the most recent being the terrorist attack on the Indian paramilitary in the Pulwama district of Jammu and Kashmir, killing at least 40 Central Reserve Force military men on 14th February 2019. As usual, Pakistan denied being responsible for any of the attacks. The Kashmir dispute is mostly a dispute over a territory and the people occupying the territory. It is in reality a highly emotional dispute which has its origins in centuries of Hindu-Muslim rivalry (Michel 1967).

After narrating the history of the formation of India and Pakistan and the roots of the Kashmir dispute in detail, it will now be suitable to move to the research design, which involves the problem statement, research questions and the methods.

NATURE OF THE PROBLEM

Since both India and Pakistan are agrarian countries, the water of the Indus River is imperative for irrigation and hydroelectric power. The crux of the water problem lies in the sharing of the river waters between the two riparian states. This problem developed between these two countries after the faulty drawing of the boundaries between India and Pakistan (Figure 5) at the time of partition in 1947 (Kulz 1969). The political boundary is not aligned along the rivers, but across the rivers.

Figure 5: Map Showing the Rivers of the Indus System Cutting Across the Political Boundary of India and Pakistan

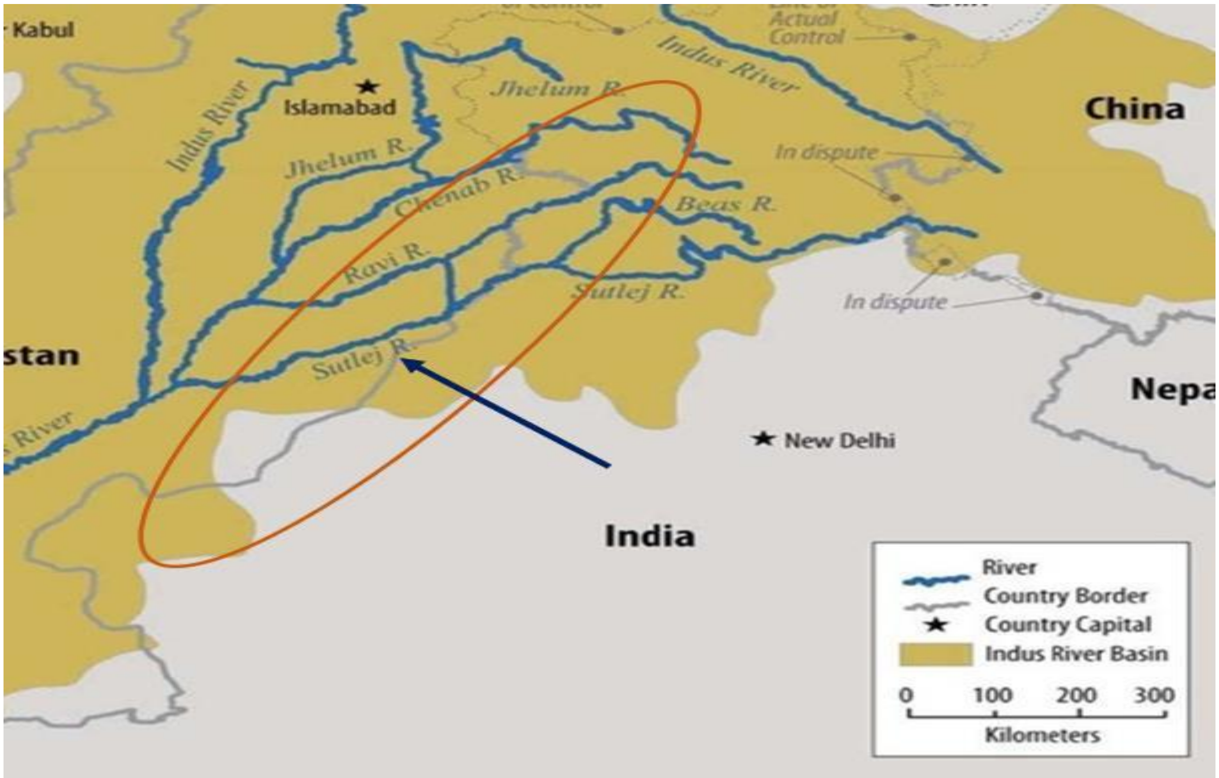


IMAGE SOURCE: Modified from Figure 2 (source: https://qph.ec.quoracdn.net/main-qimg-d272f8700fef14fbbef696da13fcbc65-c)

Before partition, the water was shared effectively between the now divided countries of India and Pakistan. However, after partition, the former state of Punjab was divided between India and Pakistan as Indian Punjab and Pakistani Punjab. The main contention in this water issue is regarding the water distribution in the state of Punjab and the district of Punjab in Pakistan, which was a contiguous area before partition (Fowler 1950). Accusations have also been made regarding dam constructions by the Chinese at the source of the river in Tibet, reducing the flow to the two riparian countries of India and Pakistan (Xu 2012). Pakistan will be a barren land with no food and sustenance without the waters of the Indus and its tributaries. The river waters are of supreme importance for the Pakistani agricultural provinces of Sindh, Baluchistan and Punjab in Pakistan. For India, the waters of the Indus are important for navigation and hydroelectricity. In reality, India would be at an advantageous position if the Indus Water Treaty did not exist, as it would have access to almost 100% of the water of the Indus System, instead of only 20% which the Indus Water Treaty allows.

While analyzing the literature on the Indus Water Treaty and the Indus dispute, I found that despite the large volume of the literature on this issue very little is known of the inter-conflict years as in the minor conflicts regarding the water sharing while the treaty was being formulated. A large volume of literature on the Indus problem discusses the Indus Water Treaty in great detail (Gulhati 1973; Akhtar 2010). Nothing much has been written about the management of the waters now. Was there any prosperity in the two countries because of peaceful and proper management of the rivers? Was there any growth in the agricultural output or increase in the diversity of crops or species richness as compared to the years of crisis? These comparisons could go a long way in explaining the importance and the scale of the problems related to the threats from construction on the rivers. Another major gap found in the literature regarding the transboundary sharing of Indus waters is that very few writers try to analyze the dynamics and the contemporary situation of the water sharing. The literature mostly consists of the discussions on the Indus Water Treaty and the history of the problems that led to the formulation of the Indus Water Treaty (Gulhati 1973; Gazdar 2005). They also talk about the occasional disputes that crop up regarding the construction of dams and hydroelectric power projects. The clauses in the treaty and their negotiations have also been discussed. None of the authors considered the impact of the river on the economy and its role in the prosperity of India and Pakistan. This is a problem which I will address in my own research, by analyzing the change in crop patterns and acreage since the formulation of the treaty to current times. In fact, this is the major aim of my research.

A provision in a water treaty on how to address climatic complaints has often been used as an indicator for analyzing the resiliency of a water treaty (Zentner 2010). However, the impacts of climate on the water levels or flow of the river was not analyzed while framing the treaty, nor have the repercussions of the changing water levels on domestic life and agriculture.

The effect of the neighboring country of China, where the source of the Indus lies, has not been analyzed at all. Since China is the uppermost riparian country, it has the maximum impact on water flow to the lower riparian countries of India and Pakistan. Only if we analyze all these aspects of the Indus water division can we get a complete picture of the situation. This will aid in proper policy framing and implementation. The impact of China on this water dispute is something I will explore in my research and it will be a useful contribution to the literature on the India-Pakistan water dispute. I will mostly try to analyze this issue through key informant interviews and archival research.

Problem Statement:

The analysis of the nature of problems in the Indus Valley region shows us that there is a large scope of research work yet to be done in this area. Most of the research done in this area relates to how the Indus Water Treaty has affected the water sharing situation between India and Pakistan and the political impacts of the neighboring global superpower, China. Although the Indus Water Treaty has served as a powerful guiding tool in ameliorating water disputes, there are many factors and variables not covered in the treaty, like climate change and how agricultural productivity is affected by the water dispute. More research needs to be conducted on the effects of the water dispute on the economies of both Pakistan and India, as these are predominantly agrarian economies and their economies depend a lot on the river waters, more importantly for Pakistan. A lot of research also needs to be conducted on the effects of global warming and climate change to the volume of the water in the Indus Rivers and its repercussions on the agriculture of the two countries.

RESEARCH QUESTIONS

Looking at the nature of problems faced in the Indus region, this research aims to answer questions related to the water conflict and how this conflict has affected the economy of the riparian countries of India and Pakistan, especially Pakistan as the lower riparian country. The questions that will guide the course of this research and will help in forming a detailed understanding of the water–related problems faced in the study area and develop probable solutions in solving the better handling the water distribution are as follows:

Question 1: What is the past and present of the water sharing conditions between the countries of India and Pakistan? The aim is to understand how much water is being shared between the two countries and whether the volume of water flow has increased or decreased over time.

Question 2: How has the change (if any) in water sharing conditions since the political partition of the two countries affected the economy of both countries, and specifically the agriculture of Pakistan?

Question 3: How has the water sharing agreement affected the political relations and conditions in both the countries and what are its effects on the State of Kashmir in India?

Question 4: How far has the Indus Water Treaty, signed in the 1960s, helped in guiding and ameliorating the water related hostilities between the two countries?

Question 5: What do the future water conditions look like for India and Pakistan, especially in the Indus basin? What steps can be taken to replace the heavy dependency on Indus water?

To realize my research objectives, I will use a mixed methods approach in answering the research questions. The mixed methods approach will include the techniques of archival research, key informant interviews, farmer surveys to understand the problem at ground level, Geographical Information Systems (GIS) for vegetation analysis, and some interpretation of the coded survey data. This mix of methods is also unique because I aim at getting both the Pakistani and Indian perspective. Other than getting the perspectives of both the countries, I am trying to back up my remote sensing data with surveys and key informant interviews. Earlier researchers have dealt with the topic mainly from the GIS and remote sensing technique or just archival research and interviews. The way I am approaching this research will give me an Indian and Pakistani perspective at the same time and test the validity of these perspectives and opinions based on actual available data.

EXPECTED FINDINGS

Looking at the research questions and the review of the extensive literature on the Indus Basin for Research Question 1 and Research Question 2, what I initially expect to find is a significant change in the water flow and channel pattern. Due to intense modifications in the river channel by the building of dams, canals and storage reservoirs, since the time of partition, I expect to find a significant change in sediment flow and channel change. Crop production has not undergone significant change in terms of decrease in crop production; however, due to the increasing population and over utilization of water, there might be a time in the future when there might be intense water scarcity.

For Research Question 3, I hope to find how the sentiments of the people of Kashmir and the economy of the State of Kashmir have been affected by the water sharing agreement between India and Pakistan. I expect to read more in detail about the Indus Water Treaty and explore instances where the terms of the Treaty were used in guiding and ameliorating the water hostilities between the two countries as discussed in Research Question 4. In response to Research Question 5, I expect to find that there will be significant water scarcity in the future for India and Pakistan. With the continuous growth in population for both India and Pakistan and the growing water demands by various sectors of the economy, water scarcity will become more acute.

This research's significance lies in its attempt to provide recommendations for dealing with the already depreciating flow of the river and its tributaries. Alternative solutions and recommendations would thus aid in policy implementation and mediation. The methods that I will use to find my answers to these questions will be one of my original contributions to this research.

In the following chapters I will be discussing in further details:

- The literature involved and reviewed for this water research
- The methods mentioned above discussed in further details
- The findings of my research
- The concluding remarks about my research.

CHAPTER II

REVIEW OF LITERATURE

THEORETICAL FRAMEWORK AND BACKGROUND

Whenever we talk about the India-Pakistan conflict the topic of water wars is inevitable. The very notion of water wars is misguiding and needs to be examined thoroughly. As Karl Marx has pointed out, there had been timber wars, oil wars, fish wars, and gold wars; however, water wars seemed unlikely as most of the history is filled with wars over arable land (Uitto and Wolf 2002, 289). Wolf (1998) conducts a systematic study of interstate violence "that involved water specifically as a scarce and/or consumable resource or a quantity to be managed-i.e. where water is the driver of the event" (Uitto and Wolf 2002, 289). He points out, using this definition as a base, that in the history of mankind there has been only one water war (about 4500 years ago) and there have been "only seven cases of acute water-related violence" (Uitto and Wolf 2002, 289). The remarkable thing to notice here is the fact that water can be a cause of violence, but not war. Water can instead be viewed as a source of cooperation, which has brought even the most hostile nations to the table for amicable resolution of the problem (Alam 2002). This idea can be linked with Uitto and Wolf's (2002) point, in which a detailed study of the most vociferous enemies in the global political arena reveals that sets of nations having the greatest degree of animosity among them, which may include the Indians and Pakistanis, Arabs and Israelis, or Armenians and Azeris, all are in the process of negotiating a water related agreement or have already agreed on one (Uitto and Wolf 2002, 289).

Another opposing view point on water wars can be applicable to the Indus conflict. In his paper, Alam (2002) questions the very logic of using the term 'water wars'. He questions whether all countries wage wars against each other with arms and ammunitions just to safeguard their rights to water resources? If this was the case, then there would be no treaties on water around the world. Instead, every country sharing common water resources would wage wars against each other. He takes the case of the Indus Water Treaty and argues that India and Pakistan would have wars against each other since 1960 for the Indus waters, instead of signing the treaty. He explains the derivation of the term from the conflict over waters in the Middle East and an alternative definition of the concept. He explains the reasons behind water disputes by providing the rationalization with the increasing requirement of water for various purposes, especially agriculture. He exemplifies this with the context of Pakistan's agriculture that is in dire need of the Indus waters. He explains the logic of cooperation in water disputes and develops on this fact by relating the characteristics of the Indus Water Treaty and the cooperation between India and Pakistan. He further goes on to explain how the World Bank's intervention facilitated cooperation on this issue. This paper helps the researcher to grasp the basic of the concept of water wars, situating it away from the political view point and nationalist instincts. It also contributes to understanding the grand nature and success story of the Indus Water Treaty in the face of troubled waters between India and Pakistan.

My research will aid in contributing to the notion that water was indeed a source of cooperation. However, in the present day and age with increasing scarcity of water and growing population, there can be a chance of water wars. In other words, my research will contribute in supporting and driving the fact that if proper care is not taken in the distribution of water resources between India and Pakistan, the hostility between these two countries might increase and indeed lead to a water war between them. This is well exemplified by the Uri terror attack by Pakistan on Indian soldiers, when India threatened to break out of the 56-year-old Indus Water Treaty, which had survived two prior full-scale wars (ndtv.com 2016).

Water related disputes in all their forms have become such a grave problem that there is a huge body of literature on water disputes. Molle (2009), traces the origins of water disputes to about the 3rd Century BC, when the Chinese discovered the concept of hydrological cycles. Early river basin development and building of reservoirs had already taken place in Sri Lanka in the late first millennium BC. By the 4th to 3rd Century BC, Chinese people were also aware of the concept of upstream and downstream relations and used this concept to destroy their downstream enemies. With further spread of knowledge and gradual improvement in understanding of the importance of water, other countries around the world started learning and working on the functional importance of river basins and the concept of upstream and downstream nations. In Europe, Philip Bauche, a French cartographer under Louis XV, had the theory of drainage systems and river basins. However, in the earlier times, the focus was more on the river than on the river basin. With the modern focus on river basins, upper and lower riparian units, river diversion began under the TVA model under the New Deal established by Franklin D. Roosevelt. President Roosevelt wanted to export the TVA model, which was a multipurpose river basin model to other countries and it was implemented in other projects around the world, like the Yangtze Valley Authority, Mekong Delta, Helmand Project in Afghanistan, Jordan River Basin (Jordan Valley Authority), Zambezi and the Volta River to name a few (Molle 2009).

Water, being a scarce resource, always has the potential to be a source of conflict. However, with the increasing global population and the growing demand for water, mankind started manipulating the natural course of the rivers trying to meet all its demands. This resulted in an increasing conflict of water resources around the world. The result of these conflicts was a developing body of literature on water conflicts and how to tackle them or prevent them.

NATURE OF INTERNATIONAL WATER DISPUTES

While examining the literature on the transboundary sharing of Indus River waters, numerous references have been found to the international laws of transnational water distribution and its comparison to other transboundary water disputes around the world. An inspection of literature from two different time periods in the 1960's (when the Indus Water Treaty was signed), and recent research shows how different progressive quantitative solutions are being offered for solving transboundary water disputes. The research done by Hirsch (1956) on transboundary water distribution and their treaties is seminal. He draws a clear distinction in the nature of utilization of water resources and reasons for the dispute. In many cases, the water dispute is not about its sharing or division but the purpose of its utilization. This is prevalent in North America and Europe (Hirsch 1956, 212). There are frequent disputes regarding whether water should be used for irrigation, sanitary needs, or navigation. However, in countries of the Middle East and South Asia, the water conflict is mainly regarding the irrigation needs of one country against the other (Hirsch 1956, 212). There is also a conflict concerning the principle of water sharing. There is the case of prior appropriation, "…that is basing its claim for continued and unimpaired supplies of water on the premise that existing water rights must first be respected and met before any new allegations can be entertained and satisfied" (Hirsh 1956, 210). On the other hand, there is the concept of equitable apportionment. This principle states that, "Existing uses of water by one country may exceed the reasonable share to which that country may equitably have a right" (Hirsch 1956, 210). The concept of prior appropriation may lead to wastage of water resources, as the state may cut down the usage of the particular river's water and utilize the water from some other source (Hirsch 1956, 210). If we try to analyze both of these principles in the light of the Indus basin, we will notice that they both have pros and cons. However, equitable apportionment seems a more ethical and logical decision in the Indus Basin case. The principle of prior apportionment may be logical as it respects historical rights. However, it perpetuates inequalities in which neither the country with a well-developed irrigation system or an underdeveloped irrigation system are to blame (Hirsch 1956). Danilov-Danilyan, and Khranovich (2013), on the other hand, use the concept of perfect competition in WMS (Water Management Systems) which is a spatially defined system and functions under stochastic conditions. The system's functioning involves two stage problems of stochastic programing. Building on this, the authors develop mathematical equations to derive the optimal conditions for the efficiency of functioning of the WMS. They also provide equations and quantitative solutions for rational use of water resources, quality control of water resources, setting accommodation prices and strategies in the absence of consensus. This aids in bringing a quantitative and technical solution to the problem of transboundary water sharing that otherwise only revolves around treaties, conflicts, and mediations. It provides an entirely new dimension to the research. These two researches are an example of the progress being made in the field of transboundary water sharing. New techniques and methods are being brought forward to solve the problem of water sharing building on the theoretical background.

HISTORY OF THE INDUS PROBLEM

The Indus River starts in Lake Mansarovar in Tibet, which are in the Himalayas, the highest mountain range in the world, and flows through India and Pakistan draining into the Arabian Sea. The terrain through which the Indus River and its tributaries flow is the beginning of the problem (The World Bank 1960). The inherent geography of the region makes it difficult to divide the river waters between the two countries amicably. Thus, the Indus Water Treaty signed in 1960 between India and Pakistan, cuts the basin into two halves instead of dividing the rivers along the Basin (see Figure 5). Before the signing of the treaty, there would be continuous problems from 1947-1960 regarding the sharing of waters between East Punjab in India and West Punjab in Pakistan. India even threatened to cut off supplies to Pakistan by building a dam at Dibalpur in the headwaters of the Sutlej River (Laylin 1960). The treaty assigned the three western-most rivers of the Indus System—Indus, Jhelum, and Chenab, to Pakistan and the three eastern-most rivers—Beas, Ravi, and Sutlej to India (The World Bank 1960). India could use the waters of the Western Rivers for building hydro-electric projects. However, there should be transparency about the issue (Laylin 1960). Problems have cropped up with India constructing the Baglihar Dam and the Kishenganga dam on the Western Rivers. Pakistan had problems with the design of the dams and fears this would induce flooding in Pakistan. Almost no scholars discuss whether the sharing of the river water between the two countries has affected the agricultural output at any level. The matter has become more of an issue of political and global superiority than arguing for logical reasons and visible consequences. This is where my research comes in. I will aim to analyze how the waters of these canals and the alternative options for individual or joint management has affected the agriculture of Pakistan and the state of Punjab in India.

While analyzing the literature, it was also observed that there are enormous chronological gaps in the documentation. The initial work on this issue consisted of the 1947-1960 era, which included the time frame from the partition of the two countries to the signing of the Treaty (K.K.R 1958; Kulz 1969). The work then shifted to the 1970s problem on Salal Dam and again to the 1990s with the problem of the Baglihar Project (Gulhati 1973). There is a good amount of research and literature on the mismanagement of the treaty and the arbitrations and the verdicts that followed because of the negotiations (Iyer 2002; Khattak 2008). My archival data research will help in filling up these chronological gaps and it will give a better understanding of how the water was managed during these years and whether we can take any lessons from this and implement it in the future.

Akhtar (2010) debates on whether water wars or water cooperation is the logical solution in case of the Indus dispute. The author discusses this point in the light of present political situations in India and Pakistan. She discusses how the treaty has survived the political turbulences and mutual hostility especially during 2008 terrorist attacks on Mumbai in India when the treaty was almost scrapped. A detailed analysis has been done regarding the principles of water sharing, principles of cooperation, dispute resolution mechanisms in the treaty and the recent revisions in the treaty. She discusses all the constructions on the Indus Basin with numerical figures denoting the flow and power generation capacity, thus indicating their relative significance. The most important part of her paper is that she puts forward many logical solutions to avoid disputes, in the long run. This involves joint watershed management, maintaining the quality of water, transparency in terms of data sharing and strengthening the Indus Water Commission. Thus, Akhtar's paper aids the researcher in this field to understand the effects of contemporary politics on the treaty and the practices that can be done to ensure proper functioning and implementation of the provisions of the treaty (Akhtar 2010).

NATIONALISTIC OPINIONS

A very important and interesting thing to be explored through the literature on the Indus dispute is the nature of opinion given on this issue based on the nationality of the author. Thus, it will be helpful to look at the issue both from the Indian and Pakistani point of view. This will help in providing a background for the future perception studies. Gazdar (2005) depicts the Pakistani viewpoint on the Indus Water politics. Pakistan is primarily an agrarian country. Some crops like cotton are extremely important for Pakistan's economy. Textiles are one of the most significant exports of Pakistan, and the country's economy is thriving on it. The paper also outlines Pakistan's agro-climatic regions and how the presence of canals and irrigation systems have made a tremendous difference demarcating arid and arable lands. The distinguishing feature of Pakistan's geography is that the entire arable plain is part of the Indus valley system. Indus is thus the lifeline of Pakistan and can be considered blue gold in Pakistan. The author brings out the local disputes over water issues in Pakistan after partition that ultimately led to Pakistan signing the Indus Water Treaty. For example, water problems in West Punjab resulted in the construction of BRBD link canal in 1948, to stop the diversion of waters to East Punjab in India. Gazdar believes that Pakistan, being the lower riparian country, has been unduly taken advantage of as it cannot have any constructions on the lower course. He questions the very decision of Pakistan signing the treaty, considering it just as an engineering solution and not a logical solution. He also accuses the then-military regime of Pakistan of not paying proper attention to India's intentions, especially in the case of the Baglihar Dam, as it did not fall into the realm of the military's core national interests. This paper helps to understand the small local disputes in Pakistan which triggered the signing of the treaty. It also helps in understanding the water problems faced by Pakistan and to analyze the distribution of the waters and their consequences on Pakistan's economy. Iyer (2005a), an Indian, wrote a reaction paper to this article. The Iyer (2005a) paper is a reaction paper to the one written by Gazdar in (2005) in the same journal on the Baglihar dam. Iyer appreciates and welcomes the fact that an Indian journal is publishing a Pakistani's viewpoint on such a controversial issue. However, he criticizes the extreme nationalism and partisanship evident in Gazdar's writing. Iyer also points out the fact that such extremism is not absent in India. However, the citizens refrain from such public display of extreme nationalism about such sensitive issues in public forums. He also brings out the positive points in Gazdar's paper and shows that we should avoid the use of the term riparian as it has no relation to rights over water in this case. He brings up the concept of territorial sovereignty in water sharing as indicated by The Harmon Doctrine and The Helsinki Rule. The "Harmon Doctrine," based on the opinion of Attorney General Judson Harmon almost a hundred years ago, "…holds that a country is absolutely sovereign over the portion of an international watercourse within its borders. Thus, that country would be free to divert all the water from an international watercourse, leaving none for downstream states" (McCaffrey 1996, 965). "The Helsinki Rules established the principle of reasonable and equitable utilization of the waters of an international drainage basin among the riparian states as the basic principle of international water law. For that purpose, the Helsinki Rules have specified a number of factors for determining the reasonable and equitable share for each basin state" (Salman 2007, 629). Iyer puts forward the point that Gazdar was putting forward the Pakistani standpoint on the issue by saying that India has no rights over the Western rivers. Iyer (2005a), also points out that according to the Treaty, India does have some rights over the Western rivers. However, India did not have the efficiency to utilize the opportunity or did not pay enough importance to it. He also puts forward the point, as in his earlier essays, whether the Baglihar dam was problematic for Pakistan just because it was in the 'core' area of Jammu and Kashmir. This paper helps to understand the dynamics of the relations between Pakistan and India because of the water issues. Also, it contributes in understanding the geopolitical and strategic implication of the Jammu and Kashmir region.

The literature from the Pakistani authors also helps in obtaining an understanding of the problems faced by Pakistan due to the sharing problems of the transboundary waters, especially in terms of waterlogging and salinity and how these affect the Indus Basin agriculture. Water logging and increasing soil salinity are common problems in any irrigation system situated in a river basin (Mohammad 1965). Waterlogging of the soil refers to an excessive saturation of the soil with water, which inhibits the ability of the crops to breathe as the air phase in the soil is decreased. This in turn leads to an increase of anaerobic activities in the soil, destruction of crop roots and a decrease in oxides of iron and manganese in the soil (Daniel 2003). Soil salinity refers to the salt content in the soil. Increased salinity can cause damage to crops and is usually a result of faulty and excessive irrigation and poor drainage conditions (ILRI 1989). In this paper, Mohammad (1965) brings out such common issues in the Indus Basin and the measures taken by Pakistan to counteract such problems. He brings out the role of the use of private and public tube wells in this respect and the initiatives taken by the farmers to promote these. He also points out how excessive salinity is hampering the crops. India’s recent developments on the rivers have aggravated these problems, and he provides numerical figures pointing out to the seriousness of the issue. He also points out how diversion of waters of the canal and reclamation of saline soils helps in controlling the problem. This paper contributes to understanding some basic problems related to the irrigation system in the Indus Basin and policy initiatives taken in this direction (Mohammad 1965).

Khattak (2008), provides a brief but detailed background of the signing of the Indus Water Treaty in 1960 and why the treaty has grave consequences for the neighboring countries of India and especially Pakistan which is a lower riparian state for the Indus. He gives a detailed description of the historical events relating to the issue and some cooperative measures undertaken by both of the countries. The crux of the paper is to bring out the pros and cons of the building of the Baglihar Dam and the Baglihar Hydroelectric project on the Chenab River in India for the agricultural country of Pakistan. The Chenab is a tributary of the Indus and is allocated to Pakistan. The project violates the clauses in the Indus Water Treaty. It would create drought conditions for Pakistan in the winter months and flooding in the agricultural plains when the excess water is released from the dams. The paper outlines Pakistan’s efforts for mediation through the World Bank on this issue and the measures outlined for each country in this matter. It outlines the diplomatic and resource requirement compulsions faced by both India and Pakistan. India cannot ignore Pakistan’s demands as it is the energy and natural gas corridor of South Asia. It also outlines some cooperative measures that have been taken in the SAARC (South Asian Association for Regional Corporation) summits regarding this issue. It proposes some of the steps that the South Asian nations can undertake with their rich reservoir of resources to develop as one of the potential World Powers. This provides a solid background for understanding the Indus Water issues and the developments taking place in this region since the dawn of the problem. It unfolds some of the cooperation issues and future mediation opportunities pertaining to the trans-boundary sharing of Indus River waters (Khattak 2008).

DISPUTED HYDRO CONSTRUCTIONS

One key aspect in understanding the dispute in sharing of the river waters between India and Pakistan, is to understand the problems that occur in the transboundary sharing because of the treaty. This specifically occurs in the form of the two countries accusing each other of constructing unauthorized dams and hydroelectric projects on each other's allocated rivers. Sinha (2006) tactfully outlines, in brief, one of the greatest disputes since the signing of the Indus Water Treaty. The Baglihar project is one of biggest disputes between the two countries of India and Pakistan after the Wullar Barrage/Tulbul dam and the KishenGanga dam. It lays out the implications of the design of the Baglihar dam that had Pakistan fuming. Disputes regarding the Indus Water Treaty had cropped up since the 1980's. However, constant suppression of the issues led to the matter taking up a bigger form. Pakistan accuses India of suspicious activities on Pakistan's share of water and also that the Indian government was following a protocol of non-compliance with the clauses of the treaty. The paper also brings out the poor condition of the state of Jammu and Kashmir in India, which is not allowed to use the waters, or the power derived from the Jhelum River. For this reason, the paper outlines the viewpoint of the state of Jammu and Kashmir and its justification for the construction of the Baglihar Dam (Sinha 2006). Mohanty and Khan (2005) lay down the basic mechanism of the sharing of the Indus waters. They provide a detailed framework of the 13 canal systems and how they facilitated the construction of dams on the upstream for India, while the canals and their elaborate branches lie in Pakistan. They also discuss the equitable apportionment principle on which the sharing of waters is based. It provides a detailed framework of the Treaty itself outlining its preamble, its twelve articles and the annexures that are all highly technical in nature. The authors also provide the reconciliation measures that are described in the annexures in case of any disputes. Next, they question why the Baglihar dam is a cause of dispute between India and Pakistan. Is it because it is in Jammu and Kashmir, the ever-disputed area? They outline how the imbroglio proceeded. The Pakistani officials wanted to visit the dam; however, the Indian authorities in fear that this might stop further construction did not allow this. Neither did they give out any details of the Baglihar Dam. It is apparent that both the states used emotional judgment, rather than economics and diplomacy while deciding on the treaty. This article helps to understand the role of foreign policies, politics, and diplomacy in solving resource disputes (Mohanty and Khan 2005).

Iyer (2005b) outlines why the Indus Water Treaty has been a model for conflict resolution over the decades. He performs a detailed scrutiny of the treaty in terms of what he called the surgery of the river system. He also puts forward some alternative ways to avoid disputes, as India and Pakistan could jointly utilize the waters of each river instead of having three each. Although this would be an expensive method, it was deemed feasible and would help to avoid disputes. It also brings out the fact the treaty is highly technical and becomes difficult even for the engineers to decipher. It should be less technical like the Mahakali Treaty between India and Nepal. The treaty is extremely detailed and has several annexures that further complicates the Treaty in times of dispute. It also shows the faulty implementation of the clauses of the Treaty by India. India can promote constructions on Pakistan's rivers with certain limitations. However, it is required to send all details of such constructions to Pakistan, which India did not follow in terms of the Baglihar Dam. He also opens a new point of research in his paper. It is the question of mismanagement of the waters in the Indus Basin by both countries. Situations might become better, and conflicts might get resolved with better management (Iyer 2005b). In terms of research, it opens up new dimensions and helps to understand and evaluate the Treaty. It is a crucial element in this research.

CASE STUDIES OF OTHER INTERNATIONAL TRANSBOUNDARY WATER DISPUTES

International transboundary water dispute case studies also bring into light the issue of political and economic interests of the sharing countries (Sievers 2002). The case of ethnic minorities opposing each other in this already exacerbated political crisis leads to worsening of the condition of the disputes, as is seen in the case of the Litani River in Lebanon (Amery 1993). The consequences of increased migration on river basins has been exemplified by research on the Jordan River (Amery 1993; Wessels 2012). The Jordan River flows through the countries of Israel, Syria, Lebanon and Jordan (Amery 1993). The transboundary water sharing issues in this country also ranges from minority issues to migration issues. The migration of the former Soviet citizens and East European citizens to Israel leads to further pressure on the Jordan River (Amery 1993). Giordano, Giordano and Wolf (2002) take case studies from Southern Africa, South Asia, and the Middle East. In South Asia. Such studies can aid in having valuable perspective in solving other transboundary disputes around the world.

NATURE OF INTERNATIONAL WATER TREATIES

An important area to consider while researching on any transboundary water dispute is to study the nature of water treaties and agreements signed between countries. The case studies of other water treaties formulated to resolve other water disputes will help me in understanding the clauses of the Indus Water Treaty better. Zawahri and Mitchel (2011), talk about the nature of treaties implemented between the states in terms of bilateral and multilateral treaties. They offer a very good explanation as to when bilateral treaties are helpful and when multilateral treaties are helpful. The study focuses on three specific situations: bilateral treaties formed for bilateral basins, bilateral treaties formed for multilateral basins, and multilateral treaties formed for multilateral basins. While deciding on what kind of treaties are helpful, they consider some important factors such as state interest, transaction costs, economic interdependence, similarity of domestic legal systems, regime type, membership of IGOs and INGOs, and distribution of power. The study stresses on the persisting issue of "fragmented governance of multilateral basins" (Zawahri and Mitchell 2011, 853) in several river basins such as the Indus, Ganges, Euphrates and the Jordan. Out of all the factors (mentioned above) examined, the three most influential factors were found to be transaction costs (higher costs stall agreements), state interest (interest in the river and the asymmetry of power helps in treaty formation), and the nature of power distribution within the basin. This work aids in forming a background understanding of the factors affecting treaties and will aid in my own study.

Tir and Stinnett (2011) talk specifically about how water treaties should be designed and differentiate between institutional and non-institutional treaties. Institutional treaties can be defined as those, "…that contain institutional features in their design—such as joint monitoring mechanisms, conflict resolution procedures, enforcement provisions, and/or the delegation of authority to intergovernmental organization…" (Tir and Stinnett 2011, 607). The authors propose that certain kinds of treaties, like the ones that deal with the primary issues of water quantity and quality, and navigation are more likely to have institutionalized governance than the ones dealing with hydropower or navigation. They test the above proposal on the basis of their data of 315 river treaties and find confirmation of their hypothesis. The authors also talk about monitoring the treaties and bring up the example of the role of the Permanent Indus Commission (PIC) in easing the fears of cheating the treaty by both Pakistan and India and also how the PIC help in complying to the treaty. The important variables used for analyzing the treaties are the number of rivers shared between the countries, pattern of river flow, levels of economic development, trade interdependence, democracy, alliance patterns, history of military conflicts, and power. This article helps in understanding the nature of the Indus Water Treaty and why the treaty is so successful in handling the water distribution in one of the largest river systems in the world. Kasymov (2011), discusses two approaches for the formation of international water treaties and water sharing. In the social planner approach there is a supranational structure which is solely created to handle water disputes between the riparian countries. This supranational structure assumes all the authority and responsibility vested in it by the mutual agreement between the riparians. The second approach is based on the idea of market regulation, "…whereby each riparian nation pursues individual gains from the engagement in a basin wide bargaining game" (Kasymov 2011, 87). Game theory and its application in water management forms the most common "conceptual reference point" in this kind of "market-driven water regime" (Kasymov 2011, 87). The author uses examples of the Aral Sea Basin in Central Asia, the Jordan River Basin dispute (Israel, Syria and Palestine), water tensions in South Asia focusing on the Ganges-Brahmaputra-Meghna River Basin, and the Tigris-Euphrates Basin to discuss the probability of conflicts in these river basins. He uses the example of the Indus Basin Treaty citing it as an example of an immensely successful treaty surviving in the face of four wars and numerous terrorist attacks between the two countries of India and Pakistan. The author concludes from his examination of the water treaties in the above-mentioned case studies that political and military tensions are mostly caused due to unilateral diversion of water in the river basins which in turn threaten the economic security of the countries involved. The added effects caused by population growth, environmental deterioration, change in quality and quantity of the available potable water further leads to a rise in social discontent (Kasymov 2011).

THEORIES OF WATER MANAGEMENT AND THEIR APPLICATION

Branching out from the various arguments on water wars were the developing theories of water management to prevent and mitigate conflicts on water. However, while most of the concepts are theoretical and may not be practical or feasible to practice in the field, it is worthwhile to study some of their basic tenets. It will be interesting to study these theories and techniques of water resource management in general and to examine if these have been used in the management of the Indus River basin.

IWRM**:** One of the most popular theories of water management is Integrated Water Resource Management (IWRM). In IWRM, the river basin is the fundamental geographic unit for management (Graefe 2011). The aim of IWRM is to understand the present condition of the water resource, create short and long-term goals for each action to be undertaken, implement the action, evaluate the progress made towards the goals and reevaluate the goals and objectives (Pahl-Wostl 2006). Graefe (2011) mentions that there is an excessive fetishism with river basins in IWRM and IRBM (Integrated River Basin Management). However, he also argues how much this fetishism is applicable in the present day "technonatural waterscape" where man controls the river channels through water diversions, building dams, etc. Even though IWRM has been a very popular theory when it comes to water management, the philosophy of IWRM has remained a philosophical myth in most countries and failed to be applied effectively in any water management action. IWRM is not a flexible management system and provides very little support and flexibility to adapt to future unpredictability or mistakes in planning and management and fails to provide a scope for the actors to learn from their mistakes and educate themselves. The IWRM is also mostly restricted to political actors and governments at stake. It restricts or has no provision for communication between the people involved at the grassroot level who are directly involved in the utilization of the water. This problem is something my research plans to address. Researching on and understanding the perspectives of the Pakistani farmers and their everyday experience with the water problem will help me to better grasp what is happening at the ground level. This will also contribute some original ground level data to some already existing numerical data on water sharing. In addition, the scope for participatory involvement and social learning is extremely limited (Graefe 2011). In our current water management practices, we need to put far greater importance on human and social behavior, with specific aspects of water management. Thus, the hydrological cycle should evolve into a hydrosocial cycle keeping in lines the Marxian explanation of the nexus between social power, capital and water (Budds 2009). Water managing in the current times should involve a polycentric administration with decentralization, involving a horizontal distribution of power. Some of the highest performances in water management have been found in polycentric water management in European and Latin American countries (Pahl-Wostl, Lebel, Knieper, and Nikitina 2012). Lower levels of water management success are found in centralized (authoritarian) countries like Uzbekistan and fragmented countries like India. Polycentric administration involves an administrative combination of countries, regions and river basins. Polycentricism helps in governance in specifically responding according to the region's heterogeneity.

Adaptive Water Management: The dissatisfaction with the flaws and inflexibility of the IWRM approach has gradually led to the formation of a modified water management approach known as Adaptive Water Management. Adaptive management believes in increasing the adaptive capacity of water in terms of all unpredictable events like flood, drought, excessive pollution, etc. It also envisages participatory management and social learning, which helps in sustainable use and management of the water resource (Pahl-Wostl 2006; Raadgever et al., 2008). The Chinese Harmony Theory is a good example of this as it seeks to maintain a balance between humans and nature when it comes to management of water resources and sustainable use. The Harmony Theory involves building a relationship between nature and humans when it comes to sustainable water resource management (Zuo, Junxia, and Jie 2013).

Multiple Criteria Analysis: Multiple Criteria Analysis involves a group of techniques (like weighted summation, range of value method, EVAMIX, compromise programming etc.) which are used for analyzing and weighing different options for decision making when it comes to finding alternate sources of water, water restoration and protecting the natural aquatic environment (Hajkowicz and Higgins 2006).

Rain Water Management**:** Rainwater harvesting, and management has always been an important solution to water scarcity. An integrated strategy of mapping, storing and capturing rainwater and using it with conjunction to surface water is important for water sustainability. This integrated technique has been used by small holder farmers in Sub-Saharan Africa (Cofie and Amede 2015).

Decision Support System and Water Accounting: This is a computer tool used by the EU specially for water management. The idea behind developing this tool is that it is not always possible to keep an account of the amount of water circulating in every part of the water cycle. The process of water accounting helps in understanding the physical availability of water and linking it with the economic costs (Pedro-Monzonis et al., 2016).

Water Trading (Market Economy): This theory suggests that water is a scarce and limited resource. Adding price to water usage and having defined water rights might help in solving the problem of excess wastage of water. Game theory allows us to consider political, economic and administrative situations between a small group with different perspectives and objectives. Game theory has been applied to the Ganges and the Brahmaputra rivers. Dinar and Wolf (1994) applied it to water trade in the western Middle East between Israel, Egypt, Gaza strip and West Bank. Findings were that economic benefits occur in this region from water trade, but political conditions may not allow it (Priscoli and Wolf 2009).

River Bankruptcy Theory**:** The River Bankruptcy Analysis is used in determining the optimum water allocation between countries. The bankruptcy solution is commonly used in economics. Based on this notion the Bankruptcy Allocation Stability Index (BASI) was developed by Madani, Zarezadeh and Morid in 2014 to settle river disputes. They propose "… developing non-linear network flow optimization models that facilitate application of four commonly used bankruptcy methods, namely proportional (P), adjusted equivalent (AP), constrained equal award (CEA), and constrained equal loss (CEL) rules to river bankruptcy problems, with respect to the water availability constraints" (Madani, Zarezadeh and Morid 2014, 3059). One good example of the use of the Bankruptcy theory in the study of water resources allocation of the Euphrates and Tigris (Mianabadi, Mostert, Zarghami and Van de Giesen, 2013).

All the above theories and practices of water management have been tested for water management in various river basins around the world. However, more research must be done on the field rather than keeping them as an academic discourse.

CHAPTER III

METHODOLOGY

To realize my research objectives, I have used a mixed methods approach in answering the research questions. The mixed method approach includes the techniques of archival research, key informant interviews, farmer surveys to understand the problem at ground level, and Geographical Information Systems (GIS) has been used for vegetation analysis. The mixed methods approach used in this research will aid in answering the pertinent research questions related to understanding the specifics of the Indus water problem. A combination of the following methods will be used:

ARCHIVAL RESEARCH

Archival Research is the most important method in this research. It will help in answering research questions 1, 2, and 4 which involve answering the past and present of the Indus Problem, how far political conditions have impacted the water sharing statistics. The historical records explored will aid in forming the baseline for answering all the research questions. The Indus water issue is a historical problem, faced by India and Pakistan since the partition of the two countries in 1947. Since we are attempting to have a comparative temporal analysis of the issue, most of the historical background data will be provided by the archival research. It will particularly aid in answering question 1 related to past and present trends of water sharing and question 4 related to understanding the details of the Indus Water Treaty. The archival data utilized will include:

- A detailed study and interpretation of the entire Indus Water Treaty, signed on September 19, 1960 involving the terms of the treaty and resolving provisions for disputes.

- A detailed case study of the water usage and sharing issues in the Indus River Basin (pre-partition in the British Era) to the formation of the Indus Water Treaty in 1960. This will involve studying the disputes between the two countries related to building controversial dams like Tulbul, Kishenganga etc. and how these disputed constructions have affected the water being released from India to Pakistan.
- Historical records of the economy of the Indus Valley and the agricultural output of the region. This will involve studying the crop output in the Indus valley from 1960 to present and its contribution to the economy of Pakistan.

The archival data will be collected from various sources as follows:

1) The World Bank archives on Indus water conflict: Since the World Bank was the key mediator in the Indus Water Conflict, the World Bank Archives will provide substantial data on the Indus Water Conflict.
2) I also tried to find archival data regarding pre-Independence Punjab water problems from the National Archives of India. Studying the Punjab problem in detail is important as the problem with Indus water sharing started with the division of waters in Punjab. Although I did not find much archival data, I ended up finding a lot of historical narrations and facts about Punjab in research papers and articles by other scholars.

KEY INFORMANT INTERVIEWS

Key informant interviews involved a combination of semi-structured and open-ended questions. Key informant interviews were conducted in India, in the states of Jammu and Kashmir. The key informant interviews have helped me to build further on the information obtained from the archival research. The key informant interviews have helped in answering and gaining a better perspective on research questions 3, 4 and 5, which will mostly help us in understanding the current trends and future expectations regarding water sharing conditions between the two countries. A total of 13 key informant interviews were conducted. The key informant interviews involved key government officials involved in managing the Indus waters. I interviewed academics in the study area who specialize in the hydropolitics between India and Pakistan.

These interviews helped me to gain potential and reliable sources of water sharing conditions regarding the Indus River.

SURVEYS

The best of research combines and compares quantitative data acquired from different sources with ground truthing. This is also my main purpose for conducting surveys. This is one of my original contributions to this body of research. I primarily aimed to conduct surveys of the farmers involved in the agricultural area of the Indus Basin in Pakistan. The surveys mostly involved farmers from the two districts of Sindh and Punjab in Pakistan (Figure 6). The surveys will help in informing questions 2, 4 and 5 which deal with the changes that have taken place in the water sharing conditions, how far the Indus Water Treaty helped in guiding the water sharing conditions, and what do the future water conditions look like for India and Pakistan. Conducting these surveys was not absolutely necessary for my research. However, it was something I wanted to explore if I got the opportunity. My preliminary research mostly involved collecting numerical figures about water sharing and agricultural statistics between the two countries. However, the surveys helped in painting a clear picture of what the farmers cultivating in the Indus Basin experience in their everyday lives. The surveys helped in understanding if these farmers face any real-time water shortage, problems of salinization and other water related issues. The process of getting access to the Pakistani farmers was problematic due to strict Pakistani visa regulations for Indian nationals. The best part about this method's contribution was that if I could get the desired number of surveys conducted which was about 30, it would have been highly beneficial for my research results. I also needed to get the IRB approval and clear certain governmental regulations for this. Since it was potentially dangerous for me to go to Pakistan as an Indian national, I took the help from some of my Pakistani contacts to conduct the surveys on my behalf. Although my initial plan was to get about 30 surveys, I ended up having only 8. Although the sample size is not very strong to assert anything concrete, it helped me to understand the opinion of farmers cultivating in the Indus Basin and provides insightful comments useful for reflecting on research questions that address the effect of water sharing on the agriculture of Pakistan. I have tried to bridge the gap with strong key informant interviews.

REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM (GIS)

Geospatial Analysis:

One of the primary aims of this research was to find out the volume of the outflow of water from India to the Indus Rivers and the inflow of the river water to Pakistan based on the rules of sharing outlined in the Treaty. However, due to security issues, and the nature of data (classified), it was impossible to get the nature and amount of hydrograph data (1950- 2018) that I required to understand the fluctuations in the volume of water sharing. I found scattered data in several places only pertaining to a few dams or a few years. Therefore, I used NDVI (Normalized Difference Vegetation Index) data for Pakistan, as a proxy data for the water sharing data, based on the fact that the agriculture of Pakistan is mostly dependent on the Indus waters and the underground aquifer is also supported by the Indus water. This will offer an idea of the trend of water inflow to Pakistan from India. NDVI was used as a proxy of the biome response to climate drivers and anthropogenic modification. The NDVI data will help me in answering research questions 1, 2 and 5 which look into the past and present of the Indus water conditions, the effects of the water sharing on agriculture and the future water condition of Pakistan.

NDVI Trend Analysis:

GIMMS-3g-NDVI (1981-2015) from the ecocast portal (https://ecocast.arc.nasa.gov/data/pub/gimms/) was downloaded. The embedded quality control flags were used to account for false positives and to mitigate the effects of clouds or snow. The quality flags were also used to distinguish high quality NDVI from gap-filled NDVI pixels derived from spline interpolation and which might be contaminated by clouds (Anyamba et al.2014). The NDVI raster files were composited by the *Kharif* (June to September) and *Rabi* (January to March) seasons to obtain season maximum and median raster layers. *Kharif* and *Rabi* are the indigenous names for the two annual cropping seasons in India and Pakistan. The *Kharif* crops also known as the monsoon or autumn crops are grown during the months of June to November with minor variations depending on the area cultivated and are harvested either in October or November. The *Rabi* crops which are the winter crops, is sown around November and harvested in Spring (April/May). The GIMMS-3g-

NDVI composite layers were overlaid with level 1 and 2 administrative (provincial and district) shapefiles. Pixel-wise spatially explicit slope trends were obtained to statistically assess whether there exists a monotonic downward or upward trend over time on GIMMS-3g-NDVI time series. Similar methods have been used successfully used for other areas like climatic trend studies using satellite VI datasets (Alcaraz-Segura et al. 2010; de Jong et al. 2011; Kim et al. 2014; John et al. 2015). Slopes trends indicate a rate of change over time, in this case the change in NDVI over 35 years. This two-dimensional slope was visualized as on the NDVI slope trend maps in figures 12-15. This helped me to analyze the condition and the trends of the agriculture over the years both at the provincial and the district levels and helped me to identify hotspots across the time series (1981-2015). NDVI median values were then extracted using the batch zonal statistics tool in ArcGIS 10.3 (Appendix 7 and 8). The sign of the test statistics indicates a positive or increasing (indicated by the green to dark green color gradients on the NDVI maps) or a negative or decreasing trend (indicated in the shade of red on the NDVI maps). The strength of the trend is indicated by the magnitude or the number in the legend. Thus, a dark red area on the NDVI maps would indicate a significant decline in agricultural productivity over the years in the NDVI time series, and a dark green area would indicate significant increase in agriculture over a period of years. NDVI trend maps with the maximum and median NDVI values (for the *Kharif* and *Rabi* season) were created to identify hotspots of change and districts which showed a significant decrease (or increase) in vegetation cover, which could mean variations in agricultural productivity. The slope trends of NDVI maximum, and median composites provide an "envelope" or the range of the variability in agricultural productivity over the years. In addition, I also created standardized anomaly charts for the districts with hotspots to identify significant deviations from the long term mean.

Standardized Anomalies:

Standardized anomalies (*sa*) of the satellite-based data were calculated, $sa = \frac{xy-xt}{\sigma}$ where sa is the standardized anomaly of any biophysical variable, in this case agricultural production (shown by NDVI) for the Rabi and Kharif season mean of a specific year (John et al. 2013). The standardized anomaly in this case is calculated by subtracting the long-term mean, xt (mean of all the years for a certain province/district) from the mean value of a specific year (xy) and then dividing the subtracted value by the long-term standard deviation (1981-2016). In this case standardized anomaly charts were created specifically for the agricultural hotspots in the NDVI maps like the provinces of Northern Areas of Gilgit and. Baltistan Punjab, Sindh, certain districts in Punjab and Sindh like Mirpur Khas, Larkana, Sukkur, and Sargodha.

Climate Data:

In order to support the NDVI data, climate data including temperature and precipitation for *Kharif* and *Rabi* seasons were downloaded (Appendix 3-6). This will help in understanding, in addition to the Indus waters, how much of the agriculture is affected by the precipitation and temperature. It will also help in understanding the temperature and precipitation trends over the years in Pakistan, thus showing if there are any effects of climate change. Seasonal composites of average air temperature and accumulated precipitation for *Kharif* (September) and *Rabi* (February) from Climate Research Unit portal were obtained (https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_4.03/). The latest CRU ts 4.03 dataset were used and "pre" and "tmp" variables were downloaded (https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_4.03/cruts.1905011326.v4.03/) for the period (1981-2016) to explain the effects of temperature and precipitation drivers on vegetation. The temperature and precipitation composites were overlaid with level 1 & 2 administrative (provincial and district) shapefiles. Maximum, median and standard deviation values were then extracted using the batch zonal statistics tool in ArcGIS 10.3. The climate data will act as supplementary data to the NDVI data in answering research questions 1, 2 and 5 which look into the past and present of the Indus water conditions, the effects of the water sharing on agriculture and the future water condition of Pakistan. Standardized anomalies were also calculated for the temperature and precipitation data (1981-2015) in order to correlate and see how the temperature and precipitation affected the agricultural hotspots shown in the NDVI map. These anomalies would help us to identify potential dry and wet years and hot and cold years and thus help us to identify the amount of influence these variables have on the agricultural production. A summarized relation of the questions to be answered and the methods to be used is shown in Table 1:

Table 1: Relation Between Research Questions and Methods Used

Questions		**Methods used**
Question 1	What is the past and present of the Indus sharing conditions?	Archival research, RS and GIS
Question 2	Has there been any change in water sharing statistics, if so how is it affecting the economy, especially agriculture of Pakistan?	Archival research, surveys, RS and GIS
Question 3	How are the water sharing statistics influenced by the political relations between both countries?	Key informant interviews
Question 4	How far has the Indus Water Treaty helped in ameliorating the water related disputes?	Archival research, Key informant interviews, surveys
Question 5	What do future water conditions look like? Is there any substitute for the Indus Water dependency?	Key informant interviews, surveys, RS and GIS

DATA COLLECTION

Statistical and archival data, key informant interviews, remote sensing and GIS has been used for realizing the objectives of this study. Statistical data from 1981-2015, regarding the crop growth patterns of important crops that act as major contributors to Pakistan's economy like wheat, jowar, maize, bajra, barley, cotton and tobacco were collected from Pakistan's Federal Bureau of Statistics and the WAPDA (Water and Power Development Authority) of Pakistan and AQUASTAT from the Food and Agricultural Organization (FAO). Archival data regarding the Indus Water Treaty and its numerous revamping and the ramifications will be collected from the World Bank archives and the vast body of literature existing on the history of the Indus conflict. I have tried to obtain the transcripts of old recordings of court proceedings on Indus Waters arbitration in the World Bank archives on the Indus Water Treaty. Ethnographic study involving interviews and surveys with farmers cultivating in the Indus Basin will also be done to understand the viewpoint of the farmers, as they are the ultimate victims of the water conflict. These interviews and surveys together with the analysis of the data, will help to incorporate measures to be undertaken for proper suggested improvements to resource allocation and utilization (Whitehead 2005).

DATA ANALYSIS

The primary focus of my research is to understand whether the water usage patterns of the Indus System had any impact on the crop production of India and Pakistan. There have been several opinions that without the Indus System, Pakistan would be a desert. To understand this relationship, it is important to form a connection between the water sharing statistics and the trends in vegetation growth of Pakistan.

Interpretation of NDVI data and climatic parameters:

I have created trends maps and charts with the NDVI data of Pakistan from 1981-2015. These charts and maps will help in correlating the climatic parameters with the NDVI data. A quick glance of these charts and maps will also guide as a quick aid for visual appreciation of the dynamic patterns (Appendices 3-8).

Transcribing key informant interviews and surveys:

I transcribed the key informant interviews which were mostly in English, with the help of a software named Express Scribe. I specifically looked for highlighting the water related issues people in Kashmir felt and how they were dealing with the water issues. The surveys that were conducted on my behalf were mostly in Urdu and Punjabi. I translated the surveys and recorded the responses. The surveys, even though few in number, helped me in understanding the perceptions of the farmers who are actually involved in farming in the Indus region and encounter the difficulties of water shortage first hand. The combination of all the methods, the data collection and data analysis have all helped me in answering the research questions discussed earlier and have pointed me towards some interesting findings which I have discussed in detail in the next chapter.

CHAPTER IV

FINDINGS

My aim in conducting this research and the methodology that I have applied was to throw light on the issues that are faced by the people using the Indus waters and which often get ignored because the major part of the limelight is stolen by the political debates between Pakistan and India.

AGRICULTURAL TRENDS AND WATER SHARING STATISTICS

The aim of the first and second research questions is to understand what is the past and present of the water sharing conditions between the countries of India and Pakistan and how has the change (if any) in water sharing conditions, since the political partition of the two countries, affected the agriculture of Pakistan?

The purpose is to understand how much water is being shared between the two countries and whether the volume of water flow has increased or decreased over time. I faced some problems while finding the official statistics regarding the water sharing numbers, as these were all classified data and not published on a website. There was some scattered information about the water storage rates of different dams. However, I did not find the composite numbers of all years from 1960- 2018, that I was looking for.

I therefore decided to use NDVI (Normalized Differentiated Vegetation Index) data of Pakistan from 1981-2015 as a proxy indicator to the water sharing statistics. NDVI was used as a proxy of the biome response to climate drivers and anthropogenic modification. “NDVI is often used around the world to monitor drought, forecast agricultural production, assist in forecasting fire zones and desert offensive maps. NDVI is preferable for global vegetation monitoring since it helps to compensate for changes in lighting conditions, surface slope, exposure, and other external factors" (eos.com 2019, para 1). "According to this formula, the density of vegetation (NDVI) at a certain point of the image is equal to the difference in the intensities of reflected light in the red and infrared range divided by the sum of these intensities" (eos.com 2019, para 2). The NDVI value may range between -1.0 to 1.0, where values close to zero indicate bare soil and large positive values indicate forests and dense vegetation in general (eos.com 2019). I have also factored in the temperature and precipitation data from 1981- 2015 in order to show that the vegetation is mostly affected by the Indus waters flowing through Pakistan and not by rainfall or any other factor. Most of the water of the Indus Rivers flowing through Pakistan is what India releases to Pakistan. India is the upper riparian to all the Indus Rivers. The fact that the Punjab and Sindh provinces have so much agricultural production is solely dependent on the waters of the Indus River and its tributaries flowing through these provinces (Figure 6). The Indus Rivers at their source are mostly fed by snowmelt from the Himalayan glaciers (Ojeh 2006). If we look at the Köppen-Geiger climate classification (Figure 7), most of the area through which the Indus flows is arid desert.

One of the primary aims of this research is to understand if the water sharing issues between the two countries affect the agricultural production in any way. In the following figures (Figures 8-11) I have tried to correlate the precipitation during the *Kharif* and *Rabi* seasons with the NDVI of the respective years. *Kharif* and *Rabi* are the indigenous names for the two annual cropping seasons in India and Pakistan. The *Kharif* crops, also known as the monsoon or autumn crops, are grown during the months of June to November with minor variations depending on the area cultivated and are harvested either in October or November. The *Rabi* crops, which are the winter crops, are sown around November and harvested in Spring (April/May). This will help in understanding if the precipitation plays a defining role in explaining the increase or decrease of agricultural activity in a region.

Although Punjab and Sindh do not have the highest rainfall (Figures 8 and 9), they do have the highest of the NDVIs among all the provinces. This means that the agriculture here is mostly dependent on the Indus water and not as much on precipitation. The amount of water available in these areas from the Indus Rivers, directly affects agricultural productivity. However, even though we see an upward trend in the NDVI for the past few years, there are certain areas in the Indus region which have decreased agricultural production as evident in the NDVI maps discussed later. This is an interesting and important fact which cannot be overlooked. The declining NDVI values indicate that even though these regions are located either near or on the bank of the rivers, the Indus waters are not sufficient to support agricultural production. This might be a precursor and a sign of dwindling river water availability. In the future with further increase in population and greater demand for water and food, Pakistan runs a high risk of problems with food security.

Figure 6: Map Showing Pakistan and its Provinces with The Indus River and its Tributaries

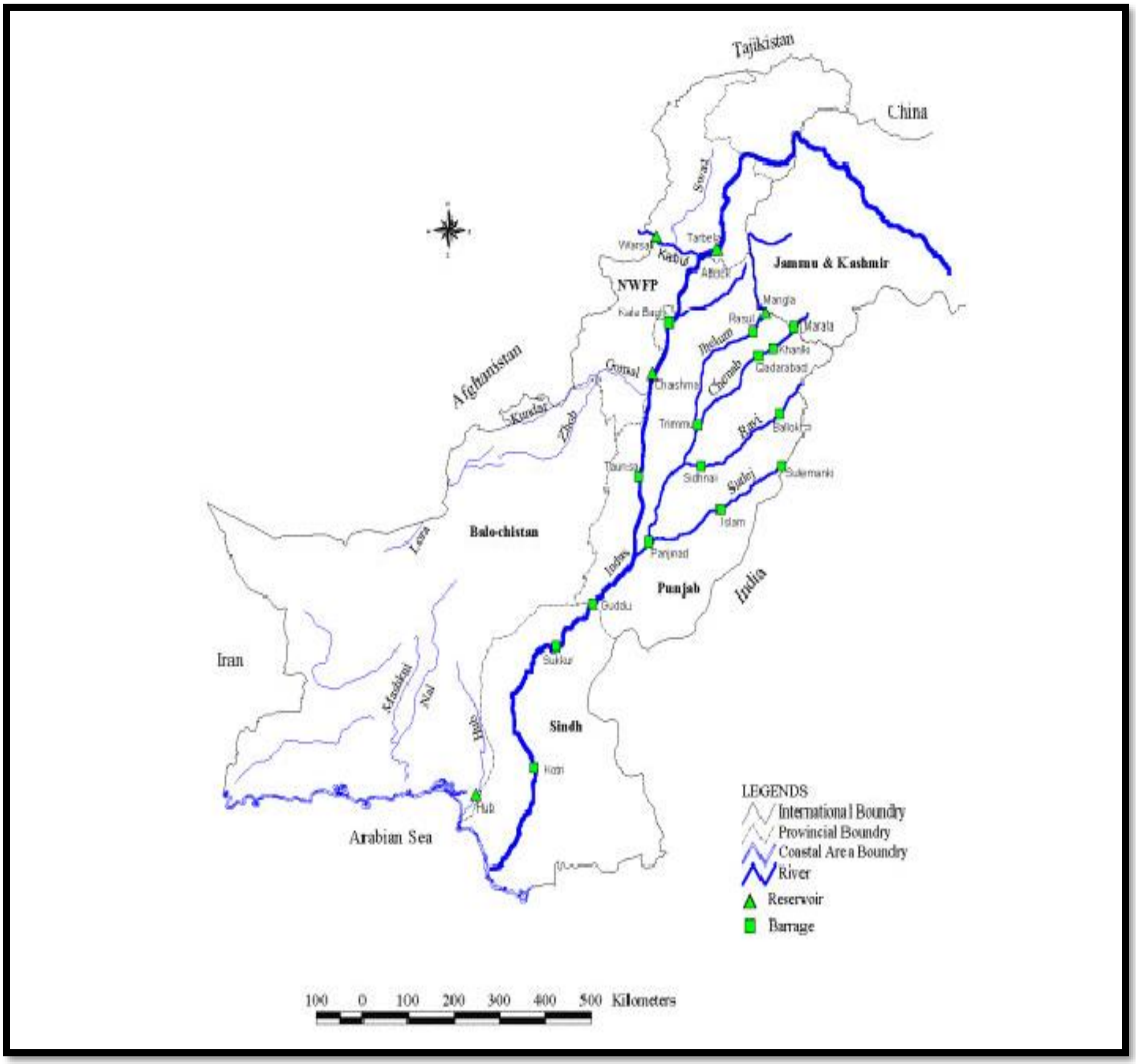


IMAGE SOURCE: Pakistan Water Gateway (*http://www.waterinfo.net.pk*)

Figure 7: Köppen-Geiger Climate Classification Map for Pakistan (1980-2016)

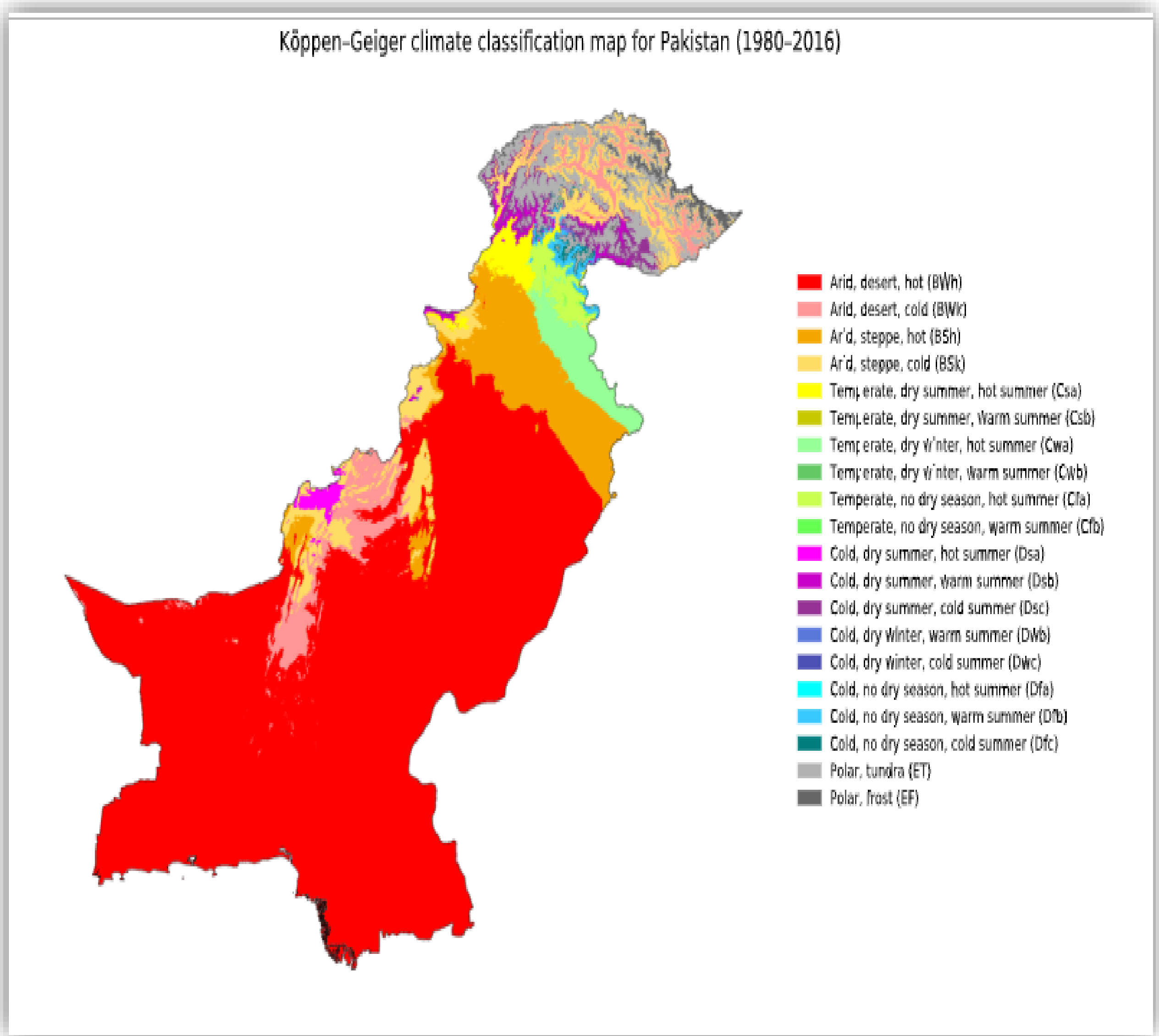


IMAGE SOURCE: Beck et al. Present and future Koppen-Geiger climate classification maps at 1 km

Figure 8: Precipitation Trends During *Kharif* Season-Pakistan (1981- 2016)

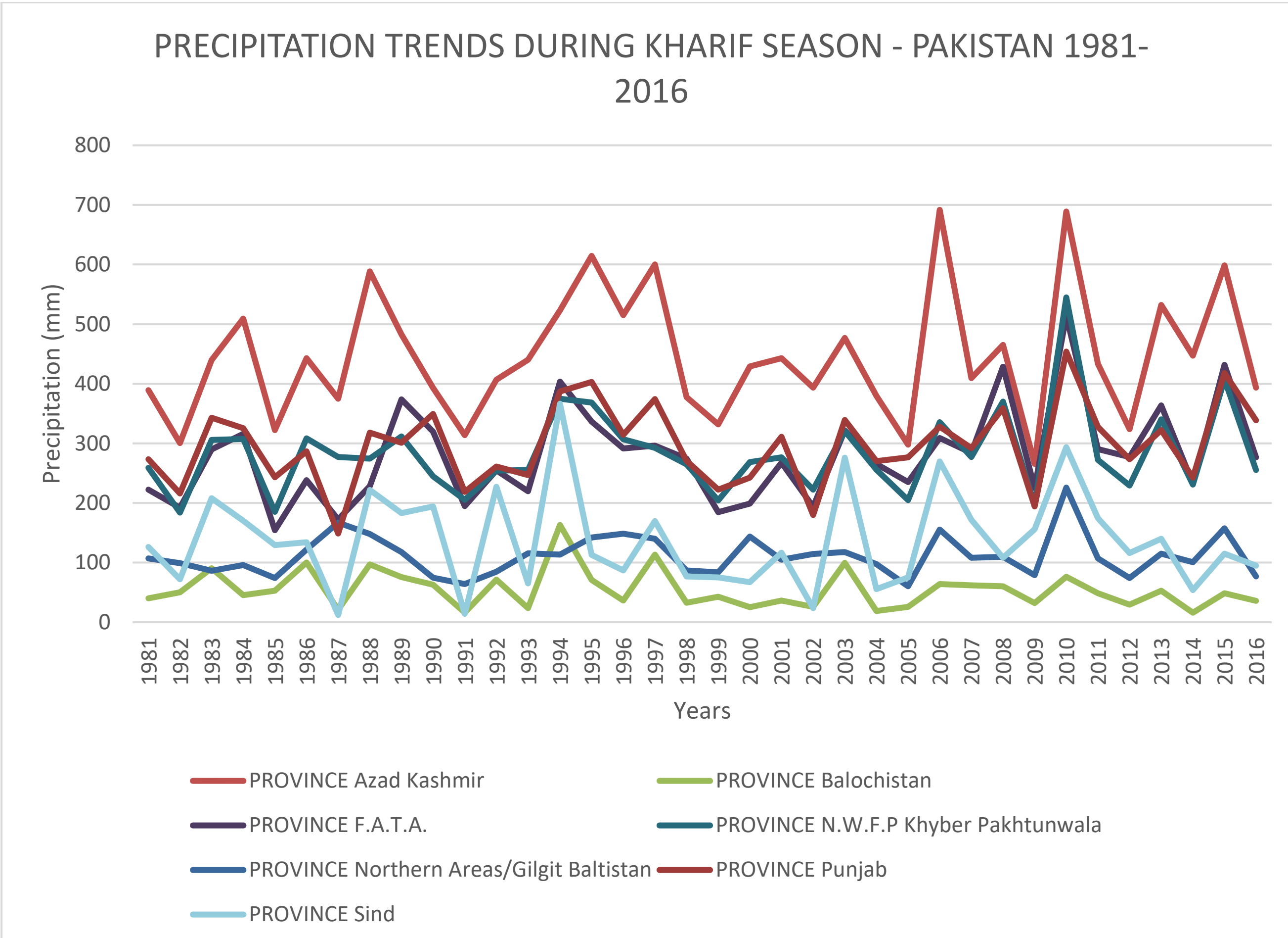


Figure 9: Precipitation Trends During *Rabi* Season-Pakistan (1981- 2016)

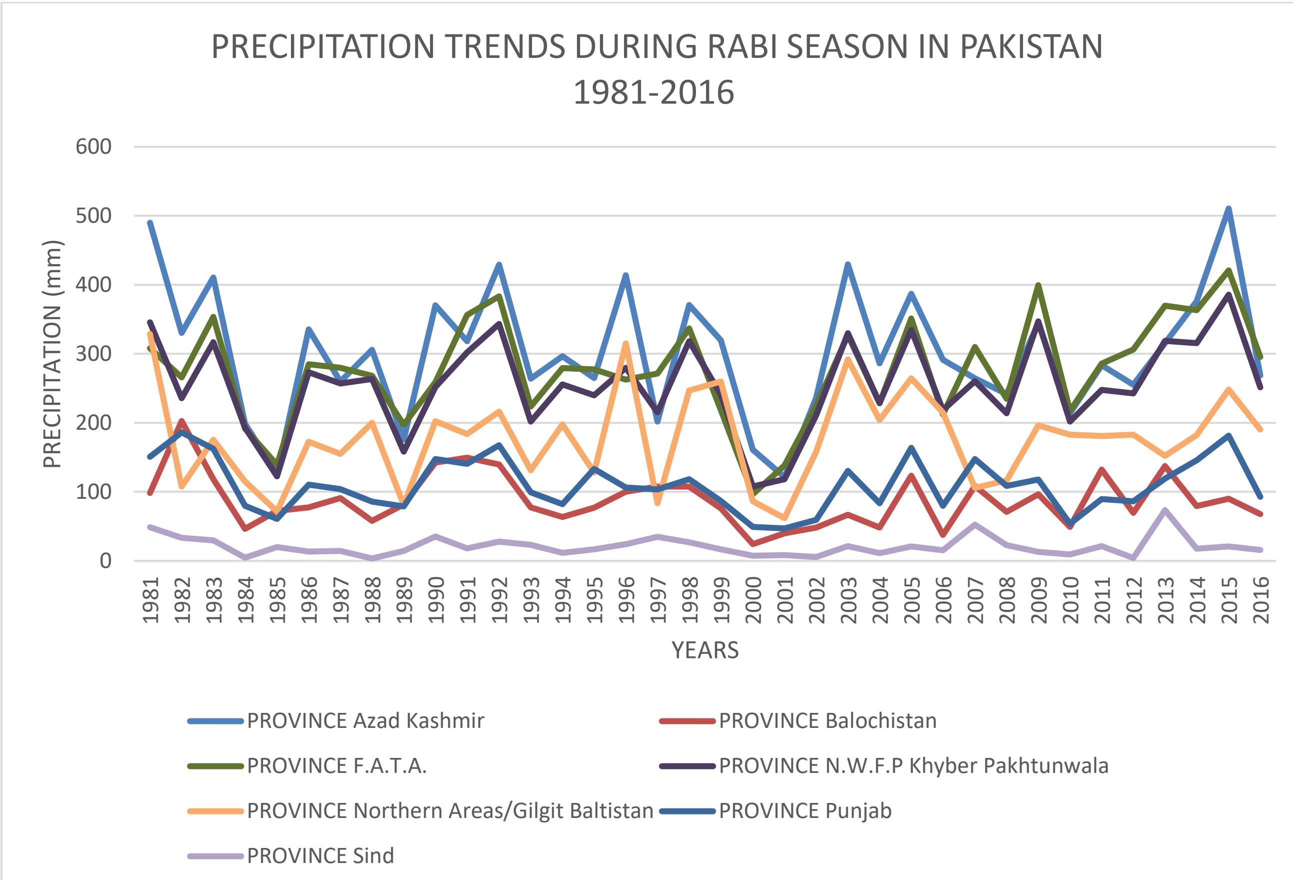


Figure 10: NDVI Trends During *Kharif* Season in Punjab and Sindh (1981- 2015)

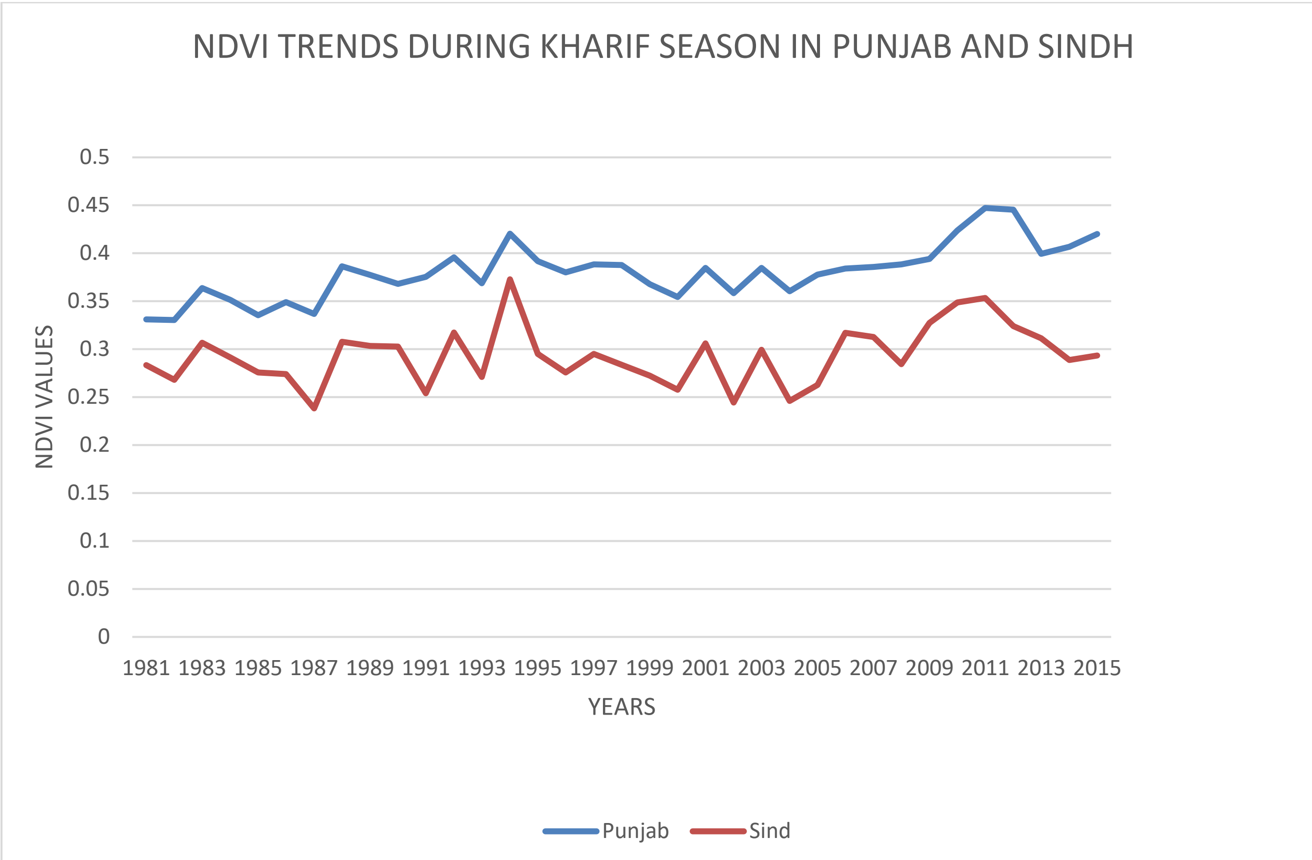
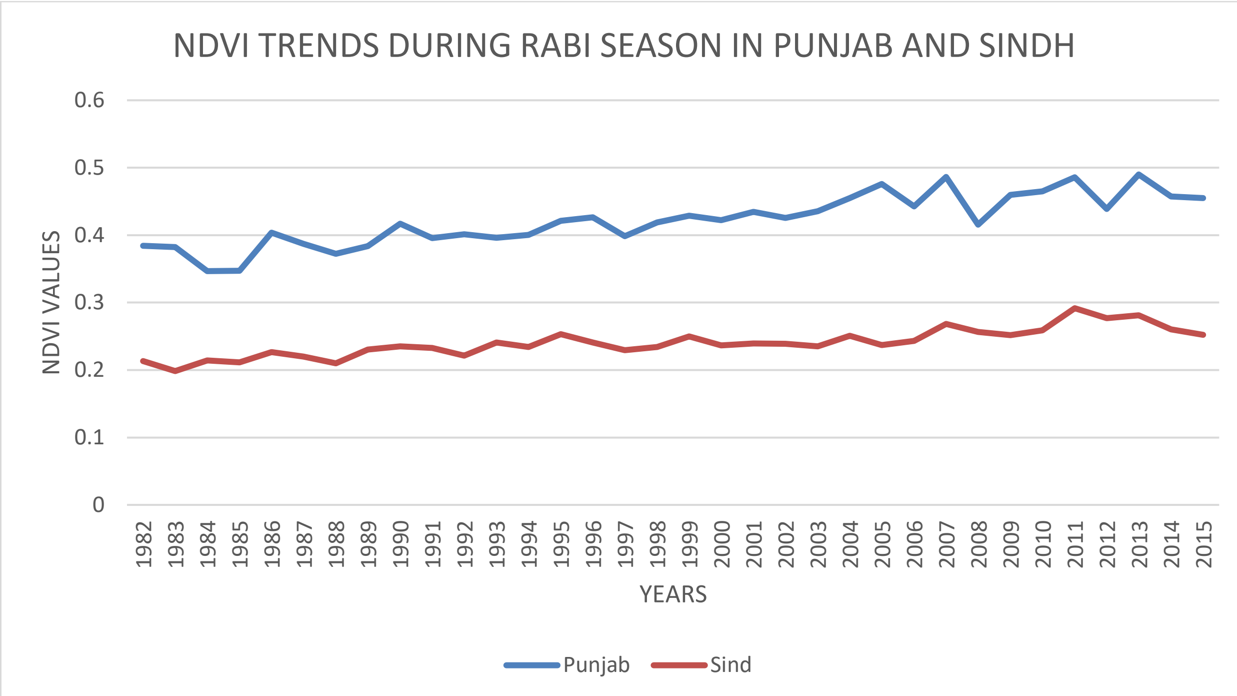


Figure 11: NDVI Trends During *Rabi* Season in Punjab and Sindh (1982- 2015)



Apart from looking at NDVI, I have also looked at the agricultural production of some important crops like wheat, rice, maize, jowar, bajra, barley, cotton, and tobacco since,

- Pakistan is the eighth largest producer of wheat in the world and it adds about 14.4% of the total value of agricultural produce (FAO.org 2011).
- Pakistan ranks 5th in the world in terms of rice exports (cia.gov 2015).
- The Pakistan bureau of statistics ranks Pakistan 5th in terms of sugarcane output between 2013-17 (FAO.org 2011).

It is also very important to realize that the majority of Pakistan's work force, about 43%, is involved in agriculture (cia.gov 2015). Therefore, problems with water may lead to many farmers without any other avenue to look to.

If we look at the maximum and median NDVI trends map (Figures 12-15), there are areas in Punjab and Sindh, which are the two most important areas through which Indus waters flow, where there has been a definite decline in cropping. The spotty areas in red around Mirpur Khas, Sukkur, Larkana, all show a decrease in NDVI, thus indicating a decrease in agricultural productivity. Even in the areas traversed by the Indus Rivers we do not see very high levels of NDVI, which can indicate that either there is a decrease in the availability of the Indus water over the years, and better irrigation techniques and better policies for conservation of water need to be implemented. A good idea would be to implement some of the theories of water resource management followed by other countries with transboundary water disputes like Integrated Water Resource Management (IWRM), or Adaptive Water Management (Pahl-Wostl, Lebel, Knieper, and Nikitina 2012, Zuo, Junxia, and Jie 2013). If we look at Figures 12-15, one theme that is dominant in all the maps are the hotspots with low agricultural productivity in the province of Sindh, especially around Mirpur Khas and Larkana. This was what I was trying to answer through my research questions, whether there have been significant changes in agricultural productivity in the Indus Basin, as we can attribute the cause mostly to the declining availability of water.

"Sindh relies almost entirely on the water of the River Indus because groundwater is 80% saline only it provides 5 million acre foot (MAF) water. As per Water Accord 1991, Sindh's share is 48.76 MAF." (Lashari and Mahesar 2012, 4). Sindh is the second largest province of Pakistan; however, it usually gets 10-12% less of the share of water allocated (Lashari and Mahesar 2012).

> Pakistan's irrigated agriculture through network of Indus Basin provides 90 percent of food and fiber requirements while "Barani" (rainfed) area contributes the remaining 10 percent. The Indus Basin System has 3 super dams, 19 river barrages, 12 inter-river link canals, 45 huge canal commands, and over 1.0 m tubewells, besides nearly 18,000 km of drainage network to dispose of agricultural effluent with one drain taking a sizeable part of the saline effluent right into the sea (LBOD). Unlike the contiguous irrigation network, the drainage network is not interconnected. Unfortunately this huge system of irrigated agriculture has not provided designed set objectives of poverty reduction. Consequently, the system has deteriorated with time due to the reasons: Separate management of various sectors (agriculture, irrigation system, environment and social), lack of coordination among

> various water related stakeholders and lack of systemic process of linkages between social, economic and environment; lack of implementation of modern technologies of water management; poor water policies, especially groundwater governance and adoption of decision support system tools; poor operation and maintenance of the system (Lashari and Mahesar 2012, 2).

Water logging and salinity are also prominent problems in Pakistan's irrigated agriculture. This problem is especially pronounced in the province of Sindh. Water logging and salinity stand as a major threat to the long-term sustainability of about 30% of Sindh's irrigated lands (Lashari and Mahesar 2012).

Figure 12: Slope Maximum NDVI During *Kharif* Season

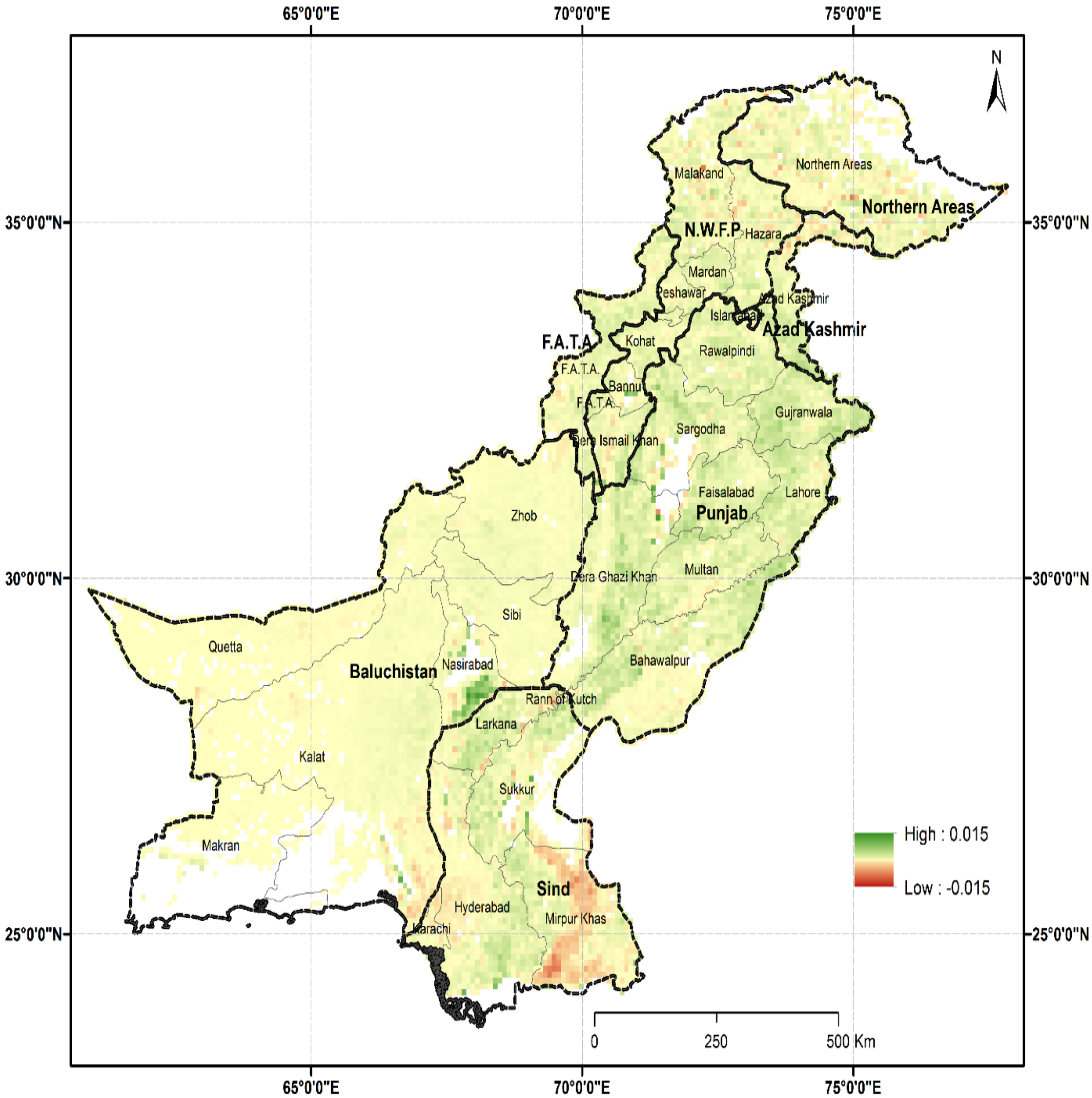


Figure 13: Slope Median NDVI During *Kharif* Season

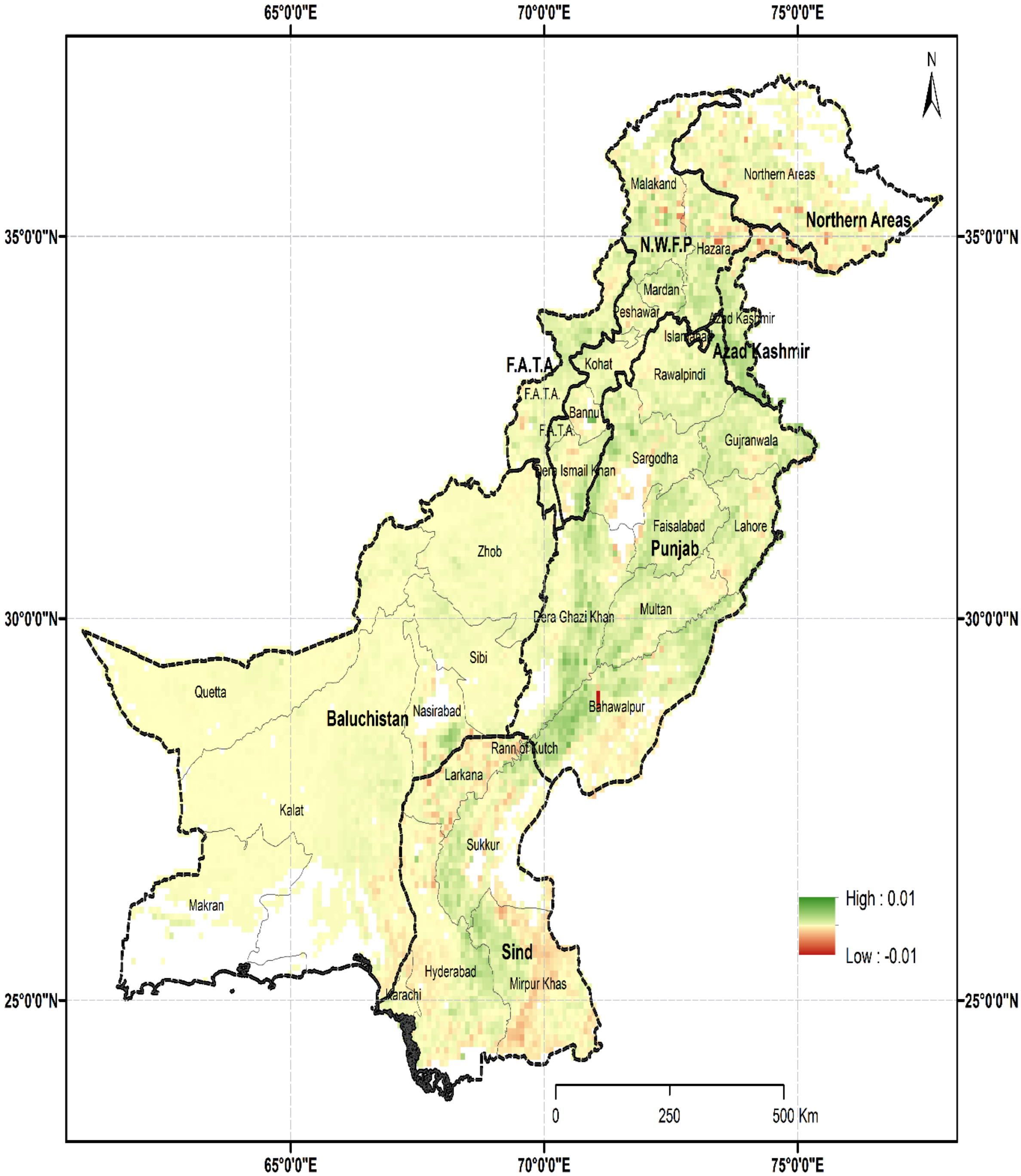


Figure 14: Slope Maximum NDVI During *Rabi* Season

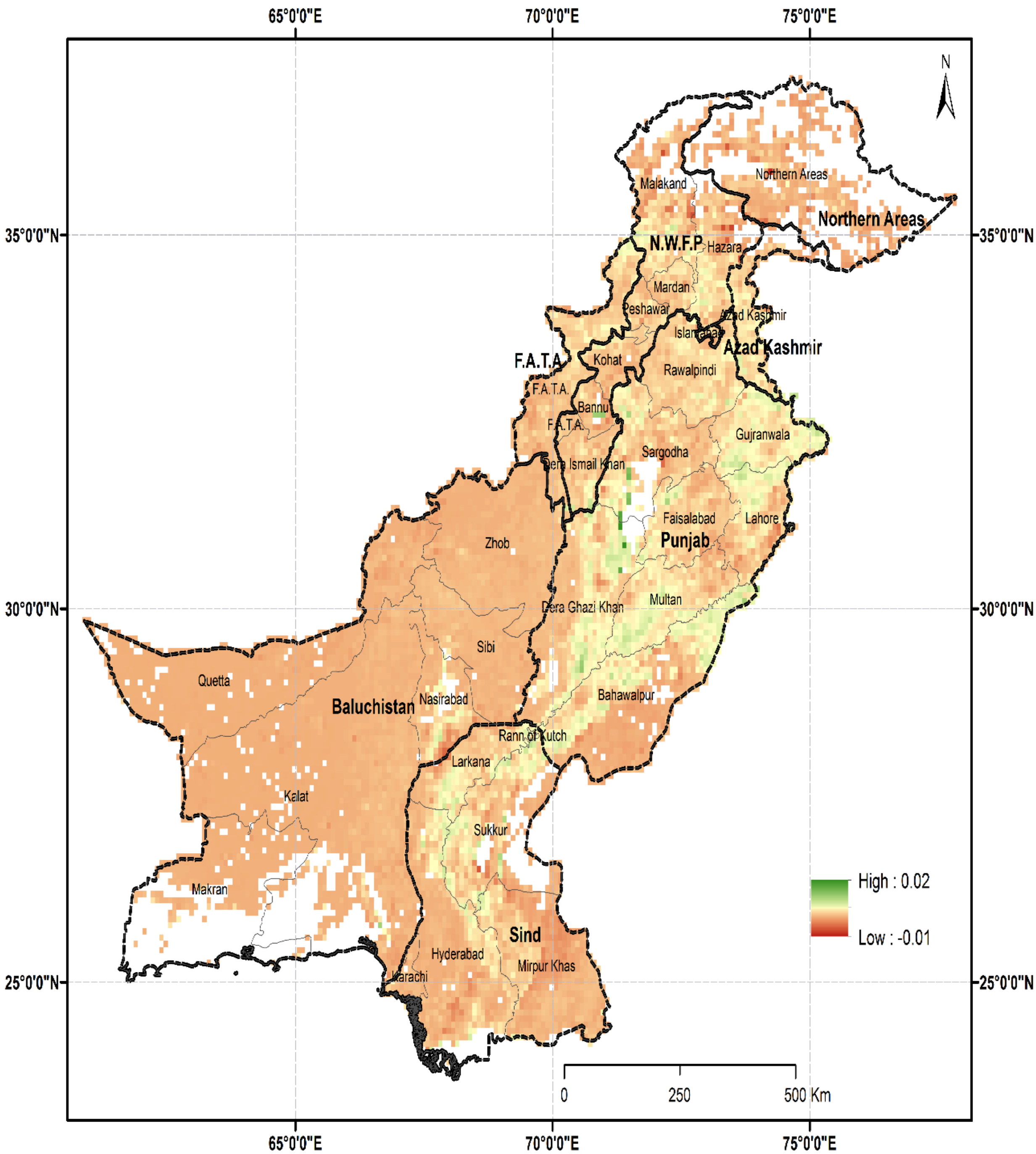
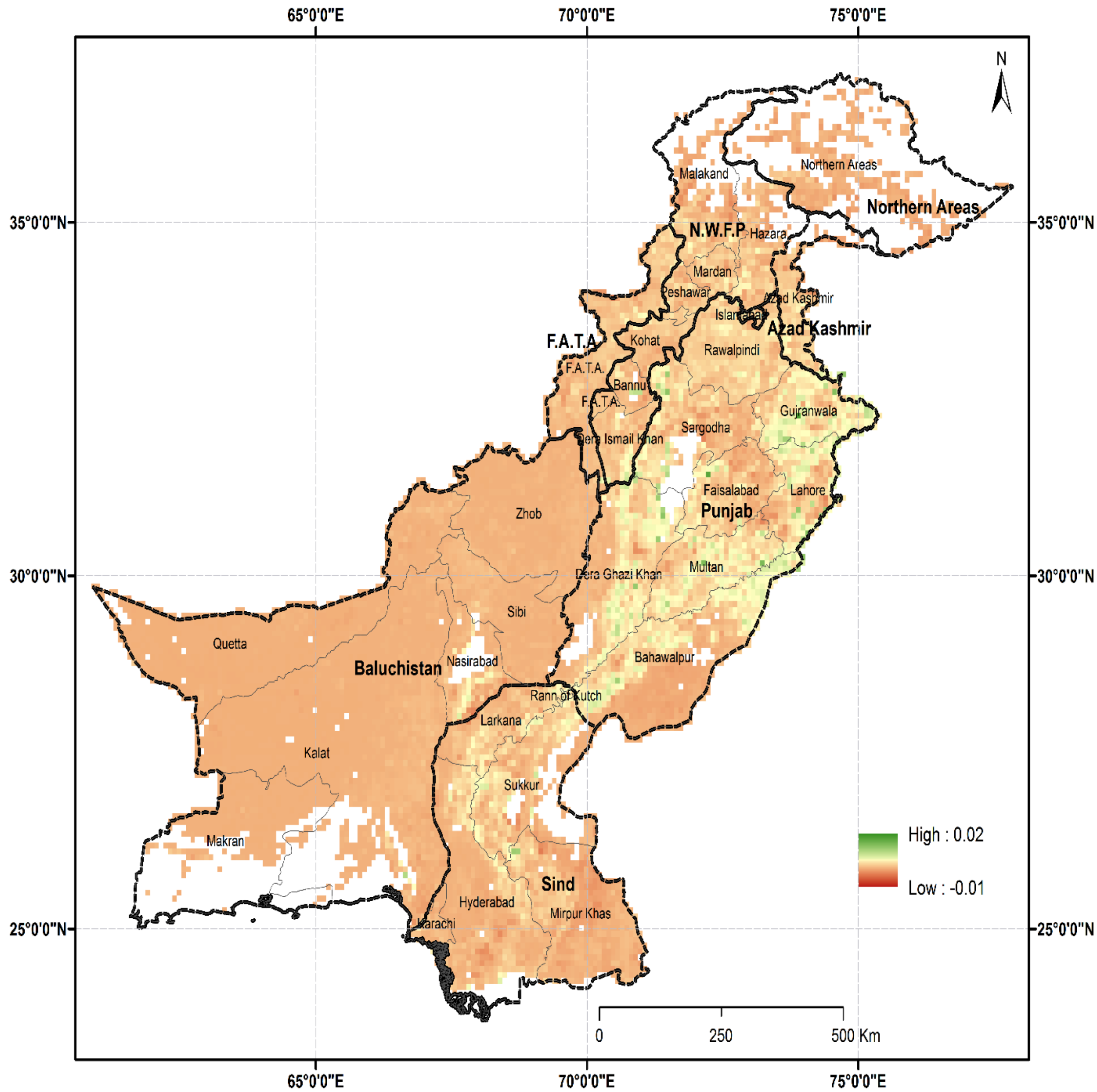


Figure 15: Slope Median NDVI During *Rabi* Season



Standardized Anomalies:

I have tried to focus on the hotspots seen in the NDVI maps by creating standardized anomalies for the precipitation, temperature and the NDVI for both *Kharif* and *Rabi* seasons. I have made charts (Figures 16-79) of standardized anomalies for the Provinces of Northern Areas/Gilgit-

Baltistan, Punjab, Sindh, and to dig deeper I further explore some hotspot districts of Punjab and Sindh with declining agricultural production like Bahawalpur, Sukkur, Larkana, Sukkur, Sargodha, and Mirpur Khas. All these districts show a significant decline in agricultural production. I am trying to explore whether the temperature and precipitation play a major part in the agricultural decline.

Figure 16: Standardized Anomalies (Precipitation) During Kharif Season in Province Northern Areas/Gilgit-Baltistan

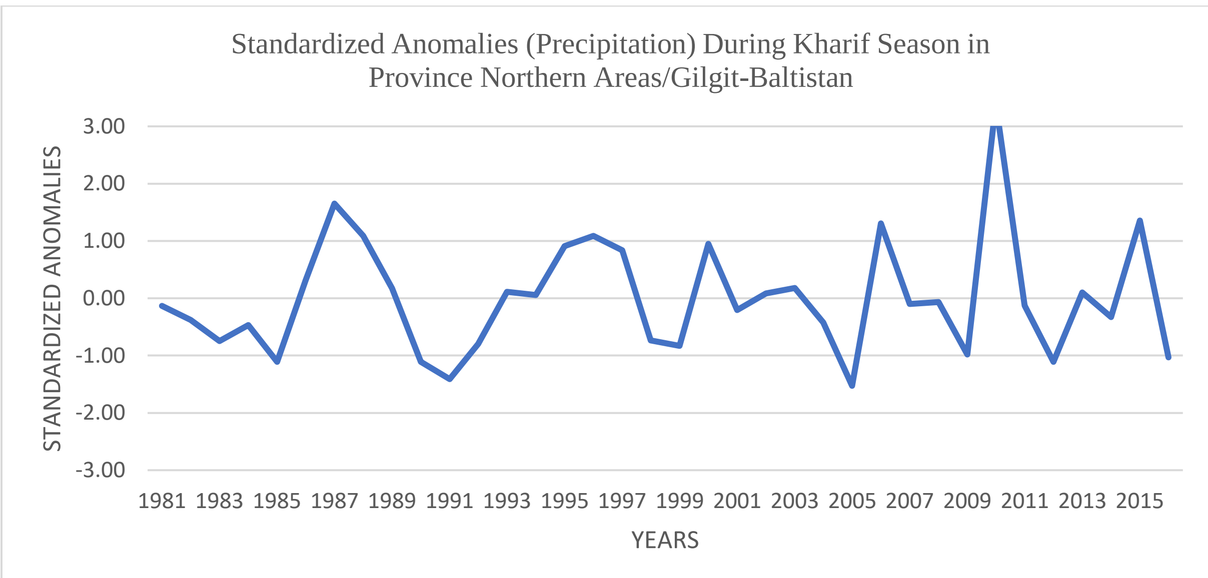


Figure 17: Standardized Anomalies (Precipitation) During Kharif Season in Province Punjab

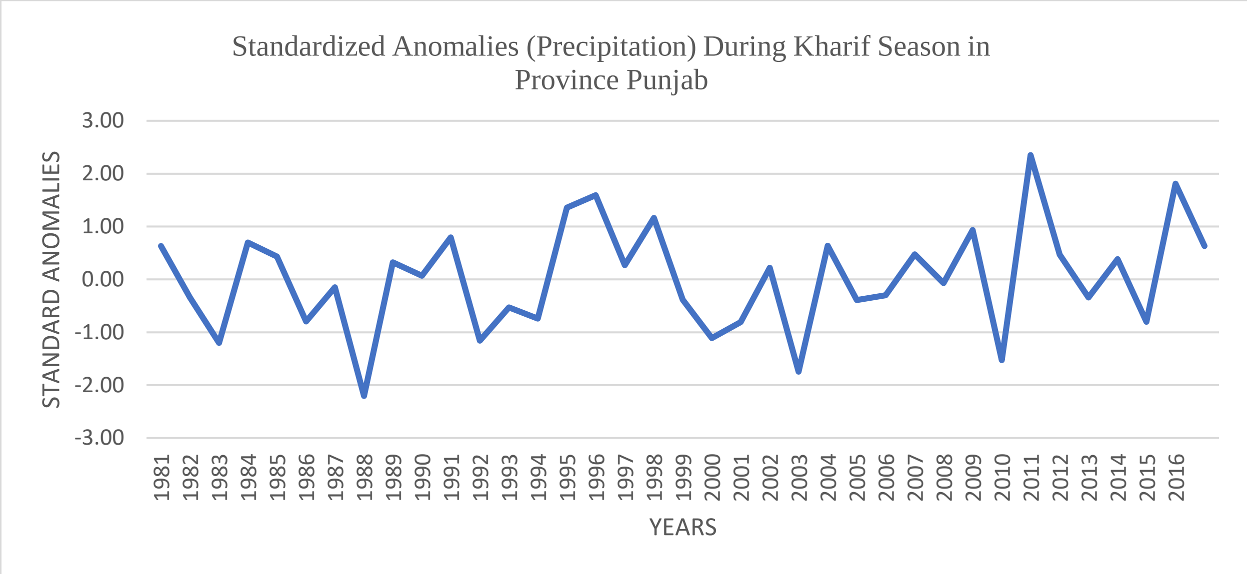


Figure 18: Standardized Anomalies (Precipitation) During Kharif Season in Province Sindh

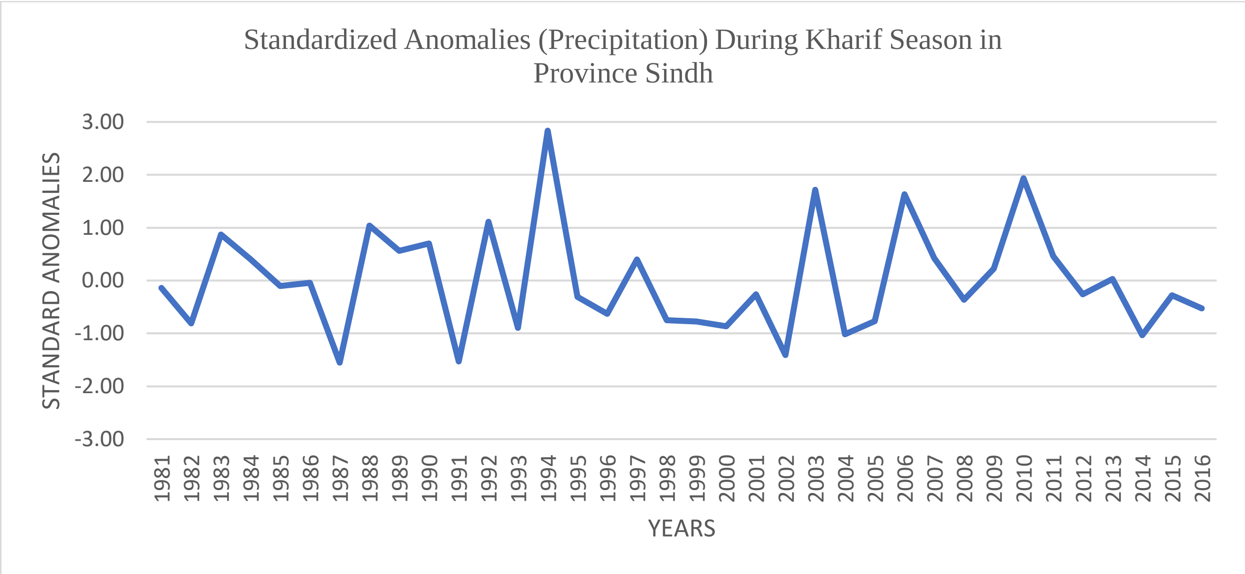


Figure 19: Standardized Anomalies (Precipitation) During Kharif Season in District Larkana

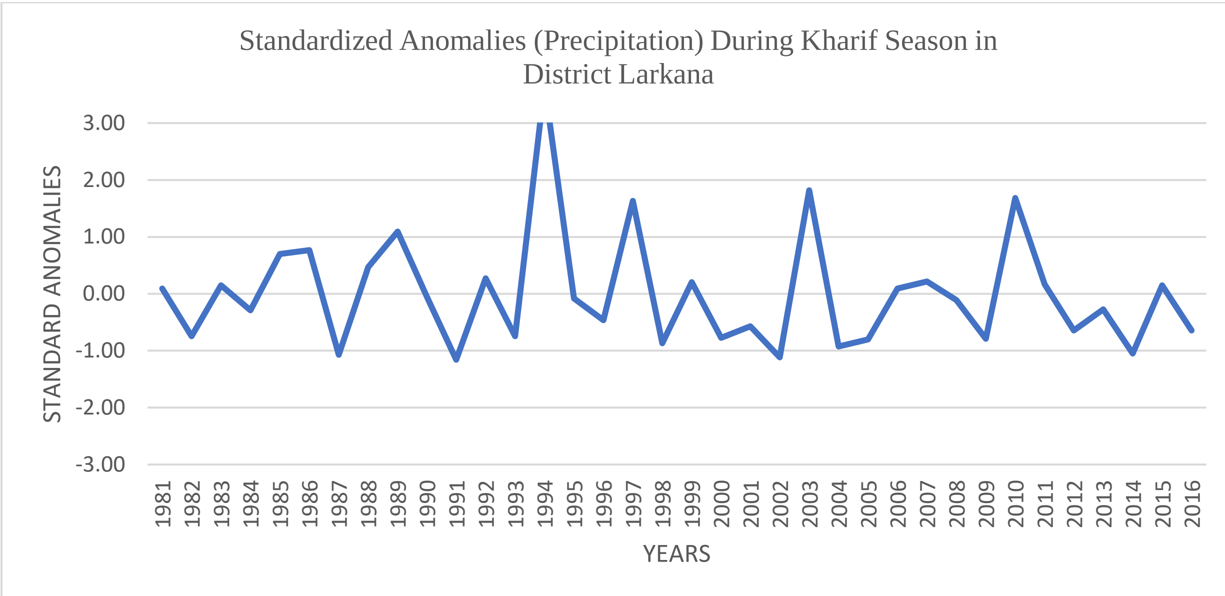


Figure 20: Standardized Anomalies (Precipitation) During Kharif Season in District Bahawalpur

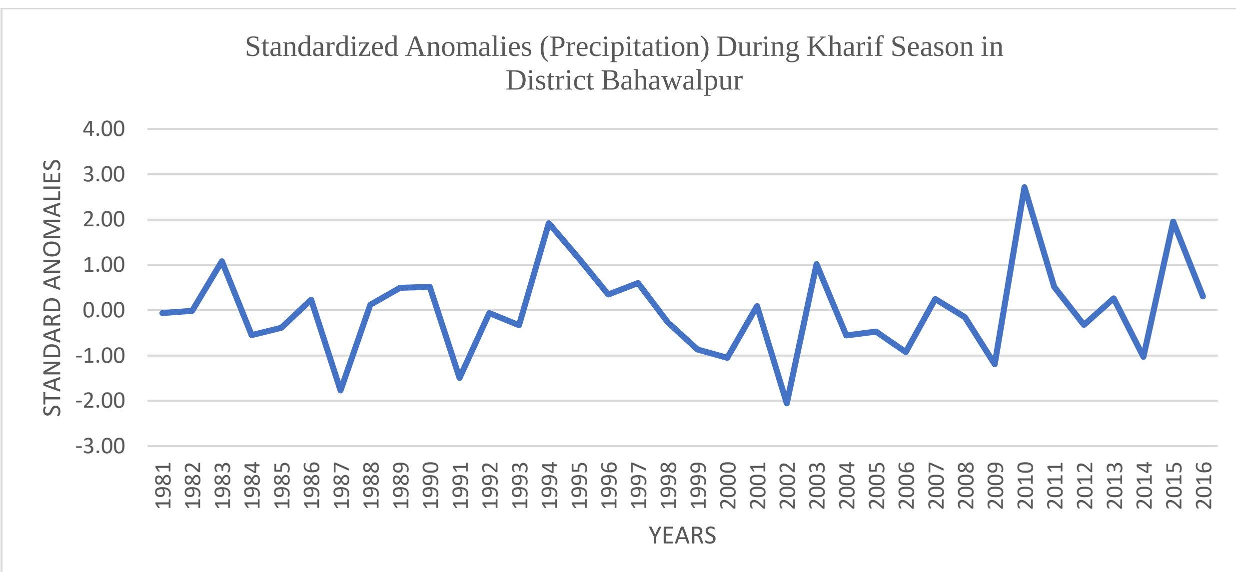


Figure 21: Standardized Anomalies (Precipitation) During Kharif Season in District Sukkur

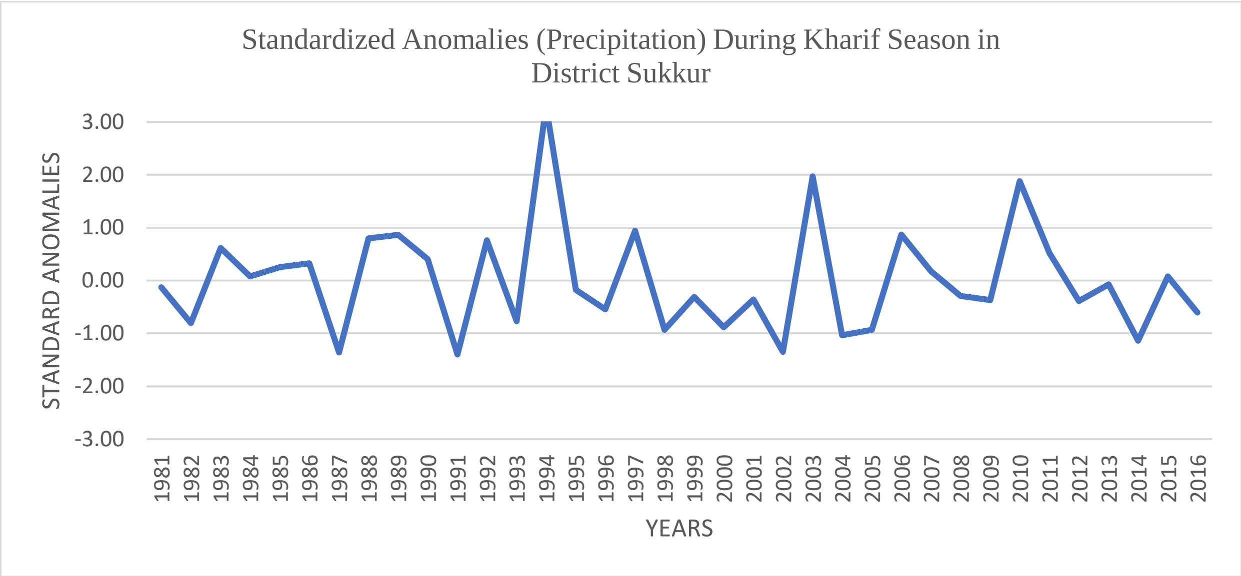


Figure 22: Standardized Anomalies (Precipitation) During Kharif Season in District Sargodha

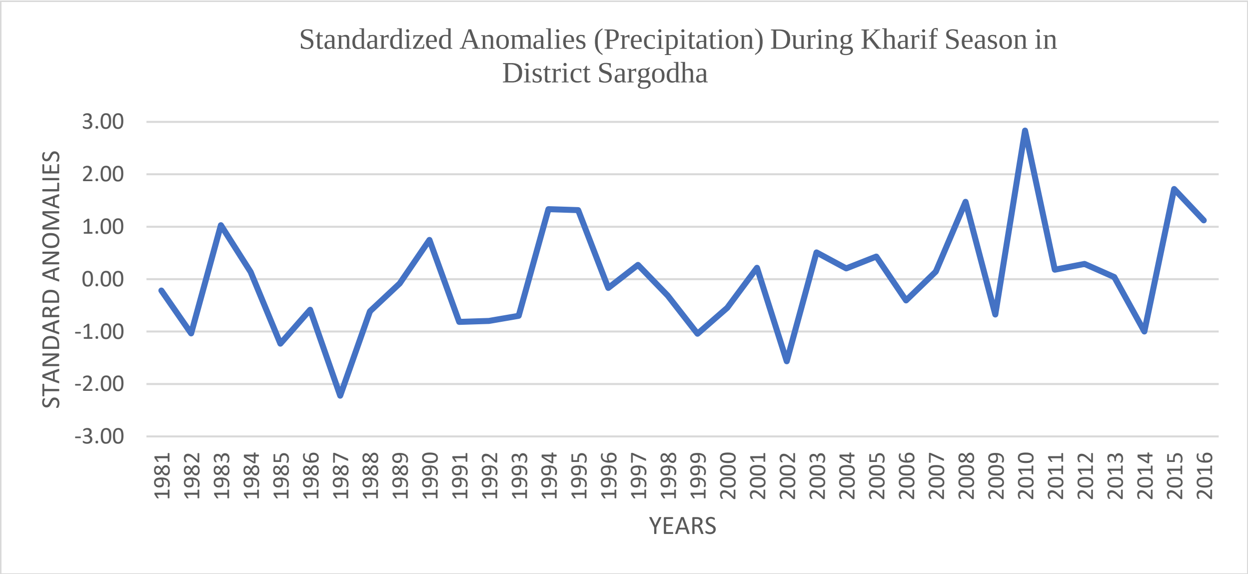


Figure 23: Standardized Anomalies (Precipitation) During Kharif Season in District Mirpur Khas

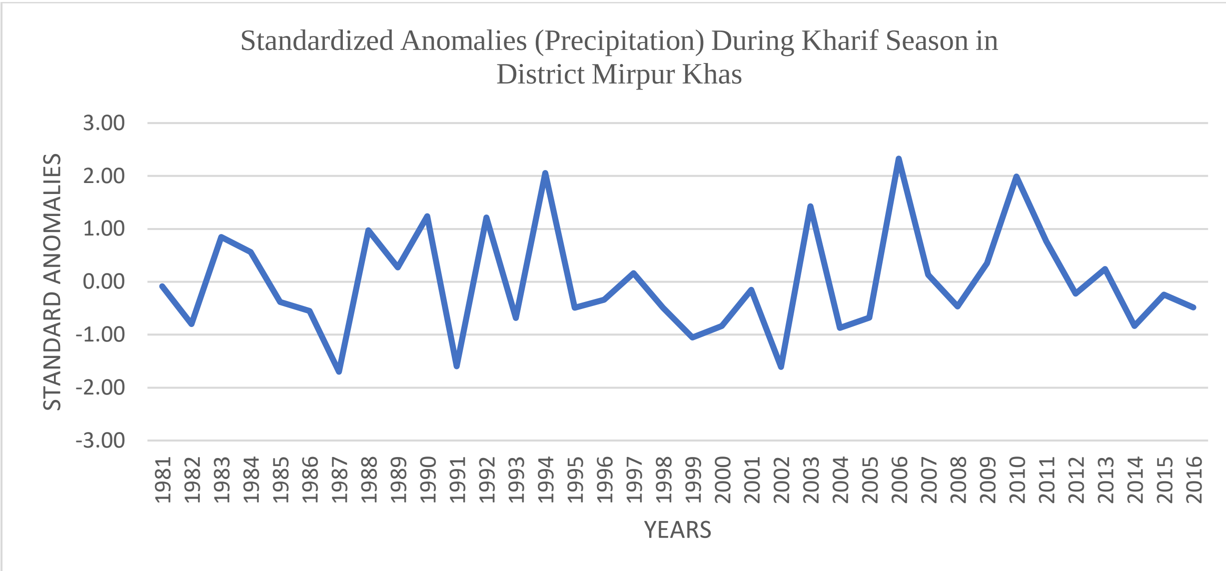


Figure 24: Standardized Anomalies (Precipitation) During Rabi Season in Province Northern Areas/Gilgit-Baltistan

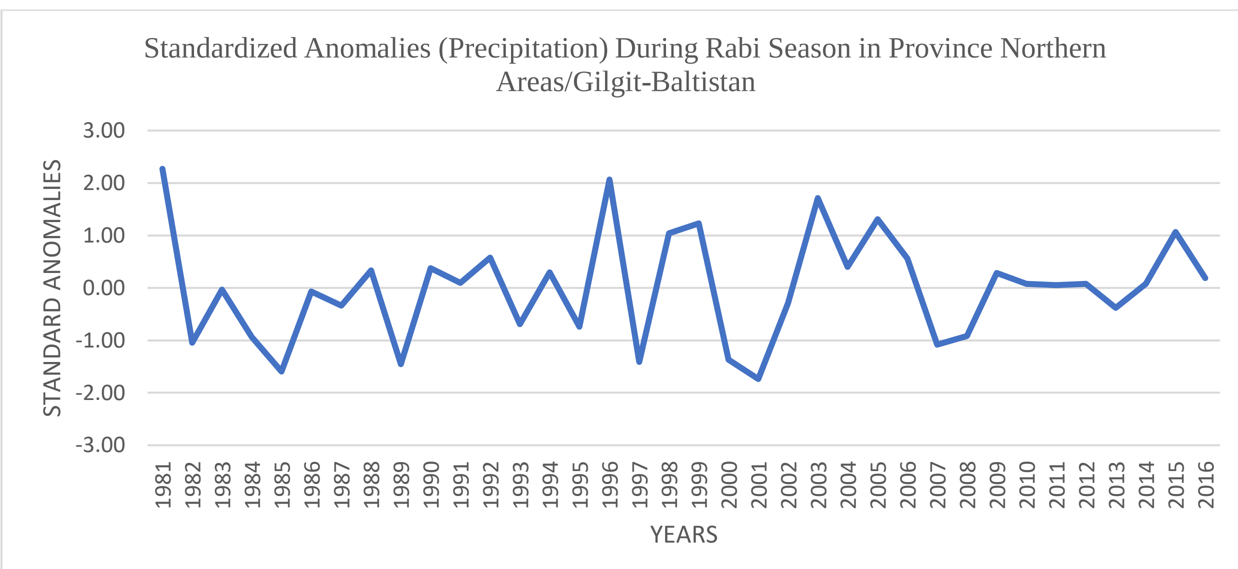


Figure 25: Standardized Anomalies (Precipitation) During Rabi Season in Province Punjab

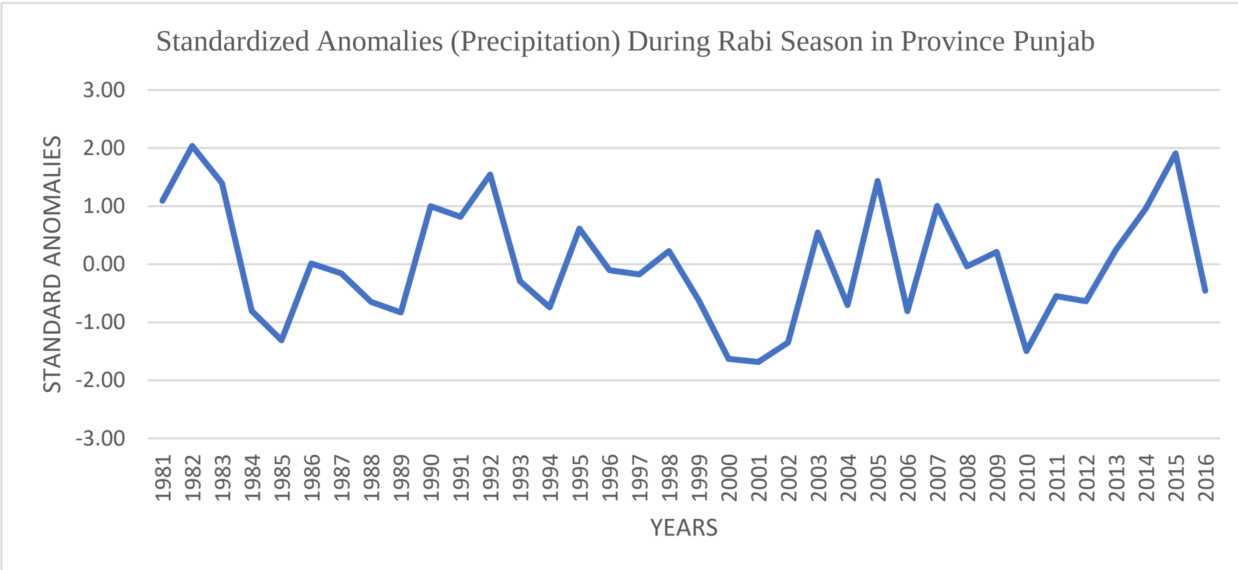


Figure 26: Standardized Anomalies (Precipitation) During Rabi Season in Province Sindh

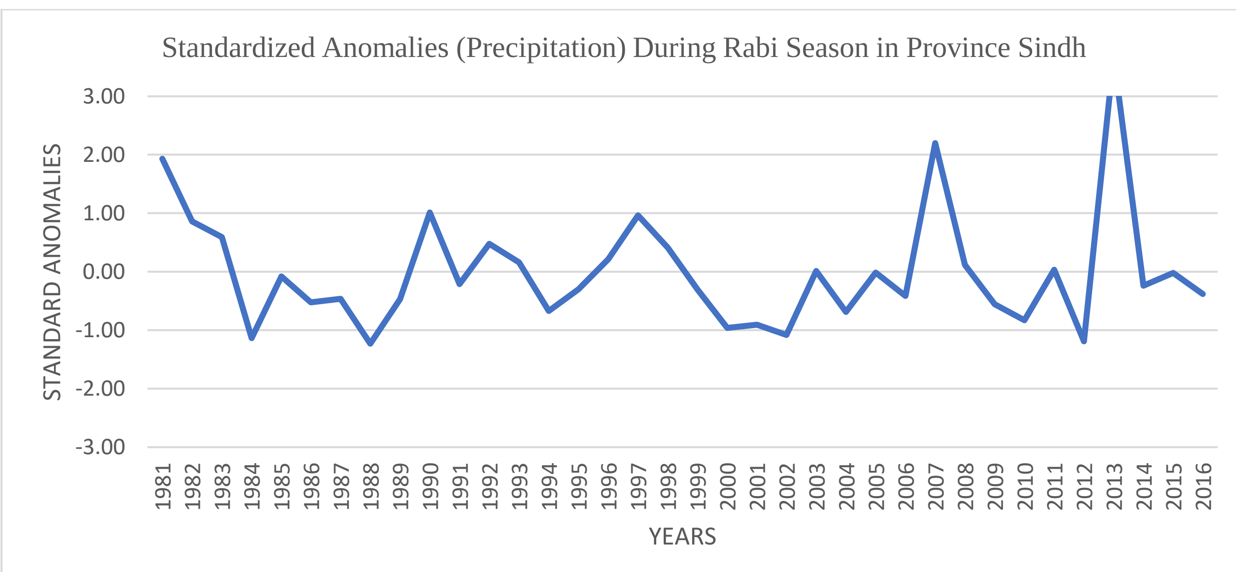


Figure 27: Standardized Anomalies (Precipitation) During Rabi Season in District Bahawalpur

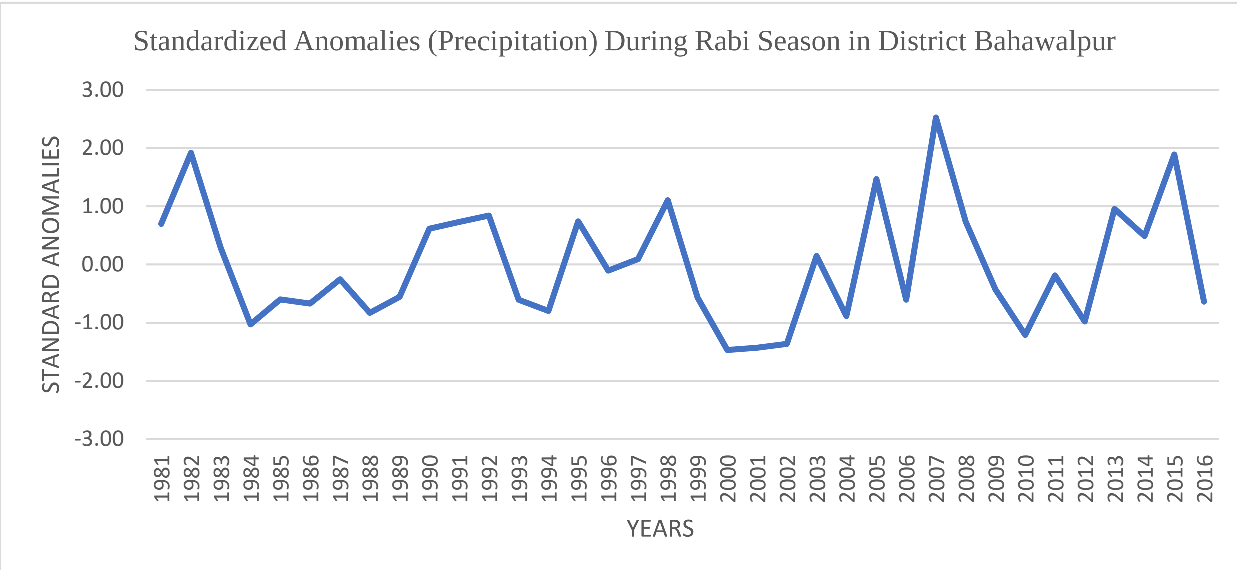


Figure 28: Standardized Anomalies (Precipitation) During Rabi Season in District Sargodha

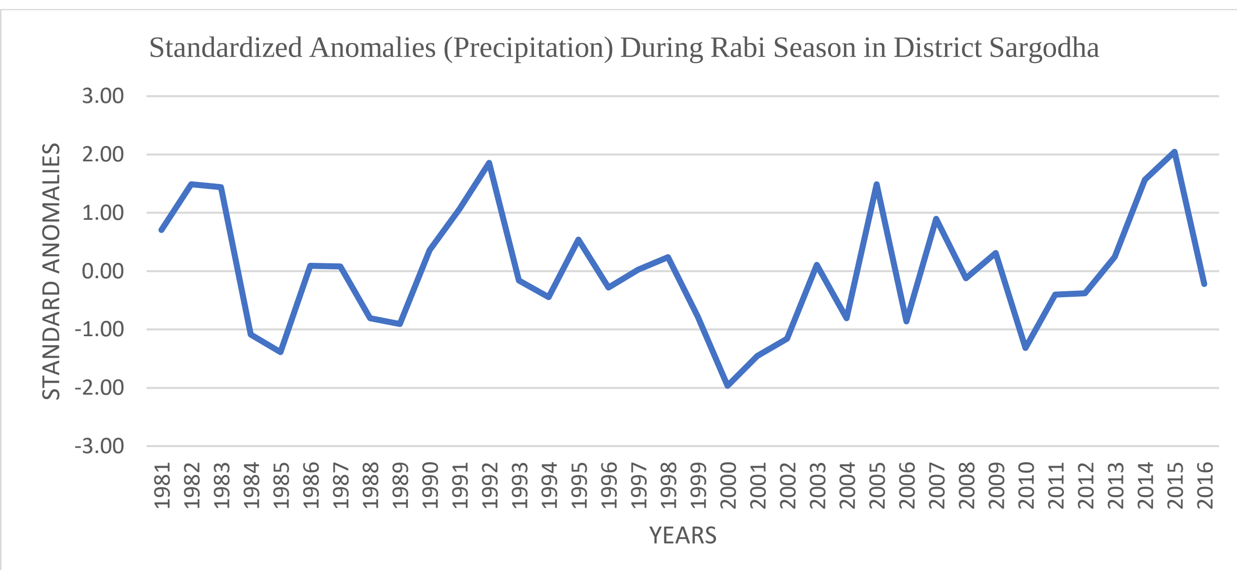


Figure 29: Standardized Anomalies (Precipitation) During Rabi Season in District Larkana

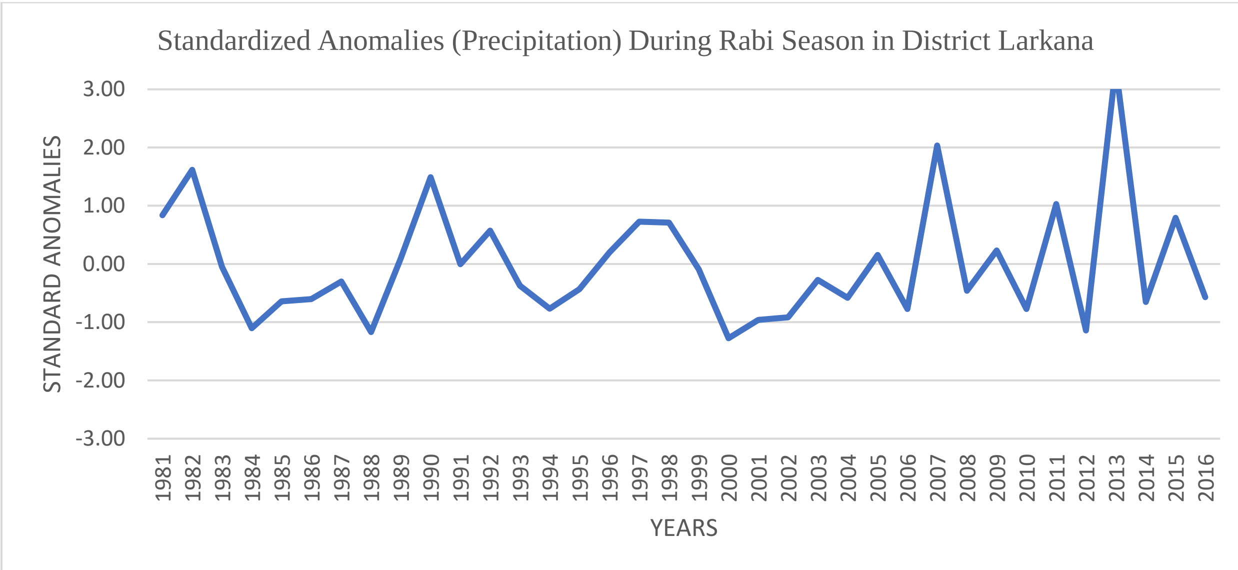


Figure 30: Standardized Anomalies (Precipitation) During Rabi Season in District Mirpur Khas

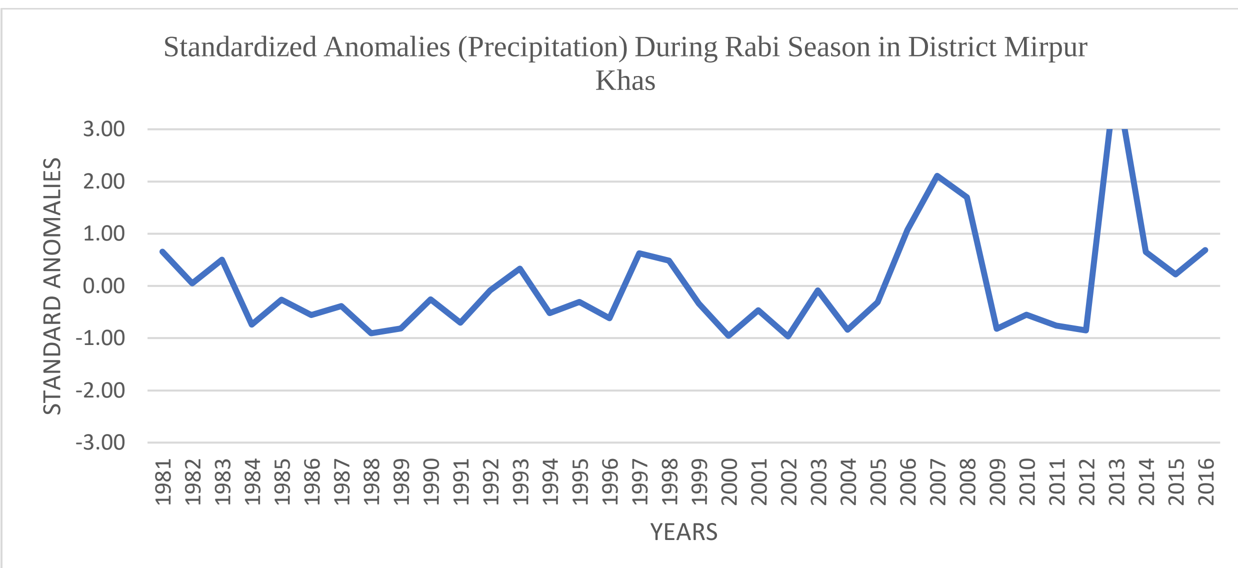


Figure 31: Standardized Anomalies (Precipitation) During Rabi Season in District Sukkur

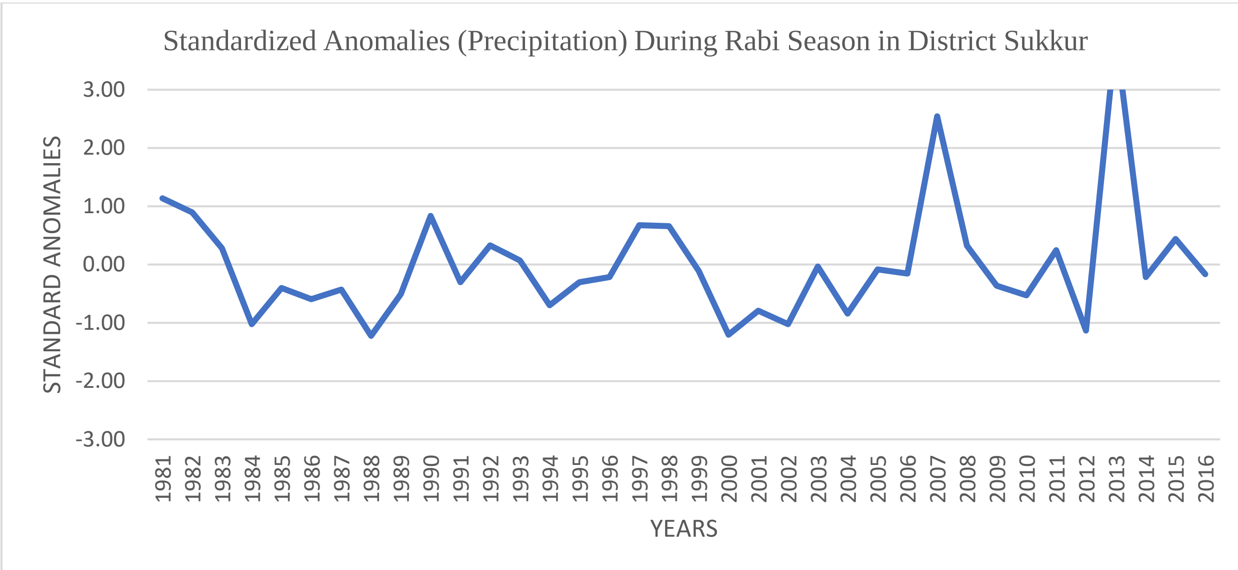


Figure 32: Standardized Anomalies (Temperature) During Kharif Season in Province Northern Areas/ Gilgit-Baltistan

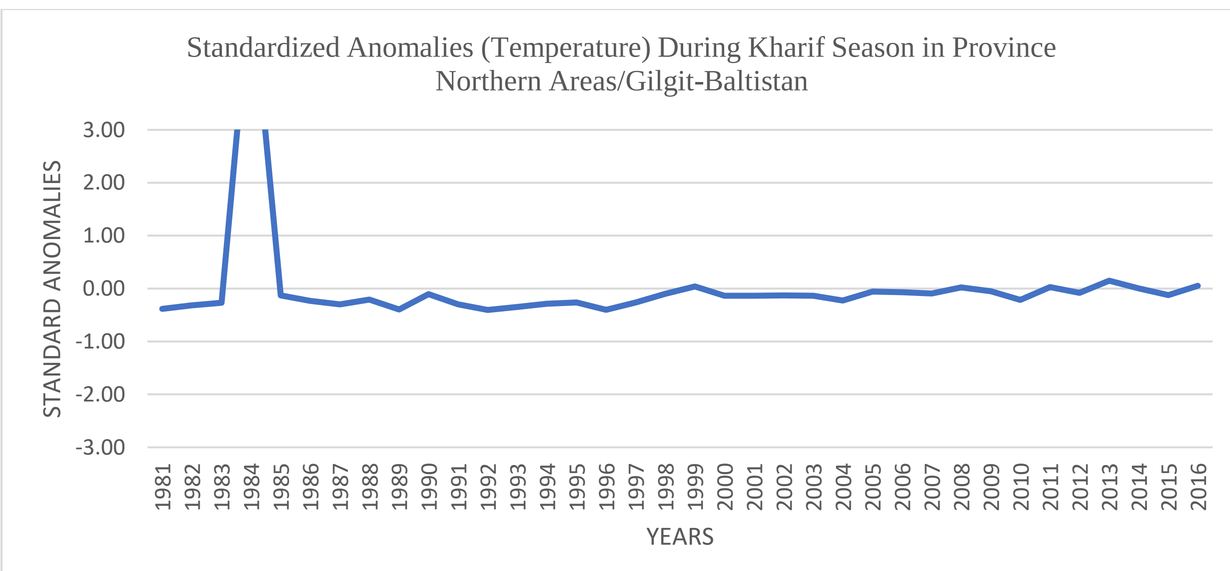


Figure 33: Standardized Anomalies (Temperature) During Kharif Season in Province Punjab

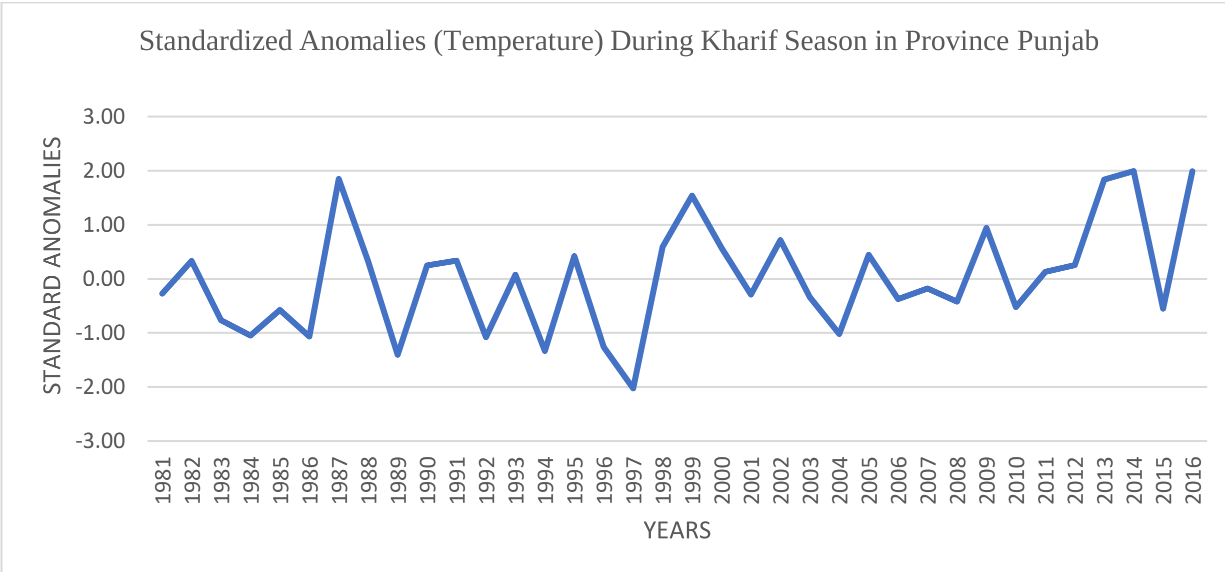


Figure 34: Standardized Anomalies (Temperature) During Kharif Season in Province Sindh

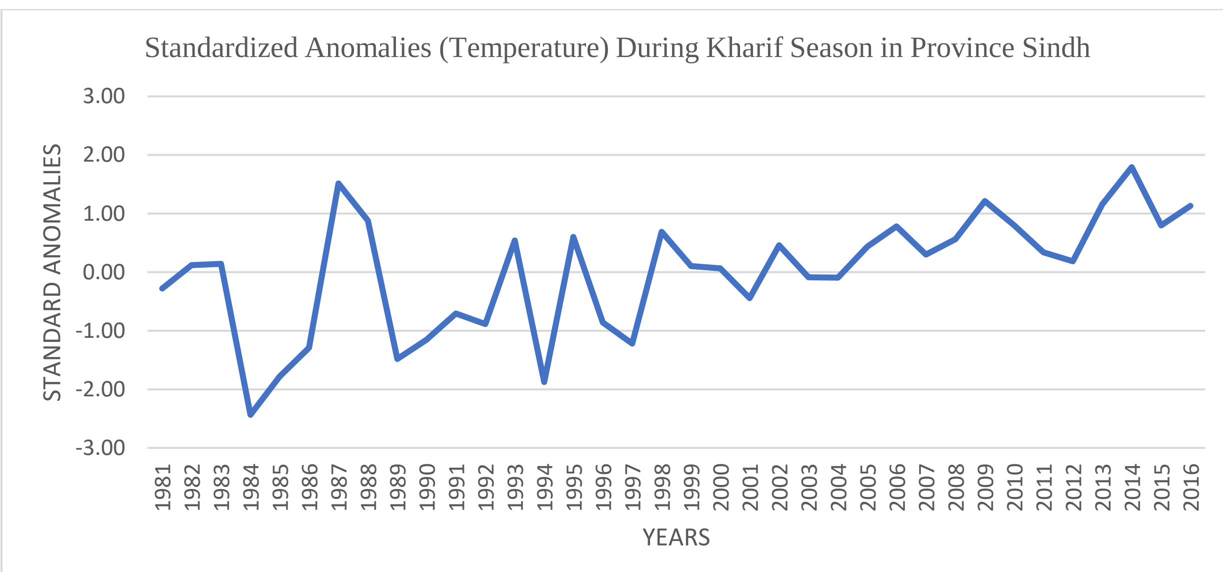


Figure 35: Standardized Anomalies (Temperature) During Kharif Season in District Bahawalpur

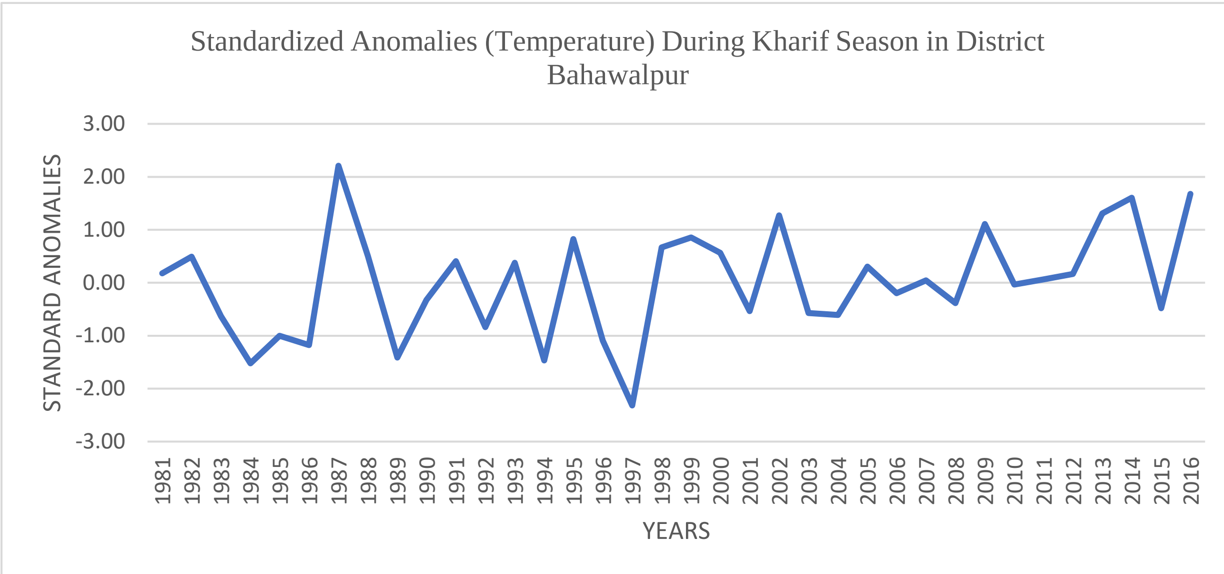


Figure 36: Standardized Anomalies (Temperature) During Kharif Season in District Sargodha

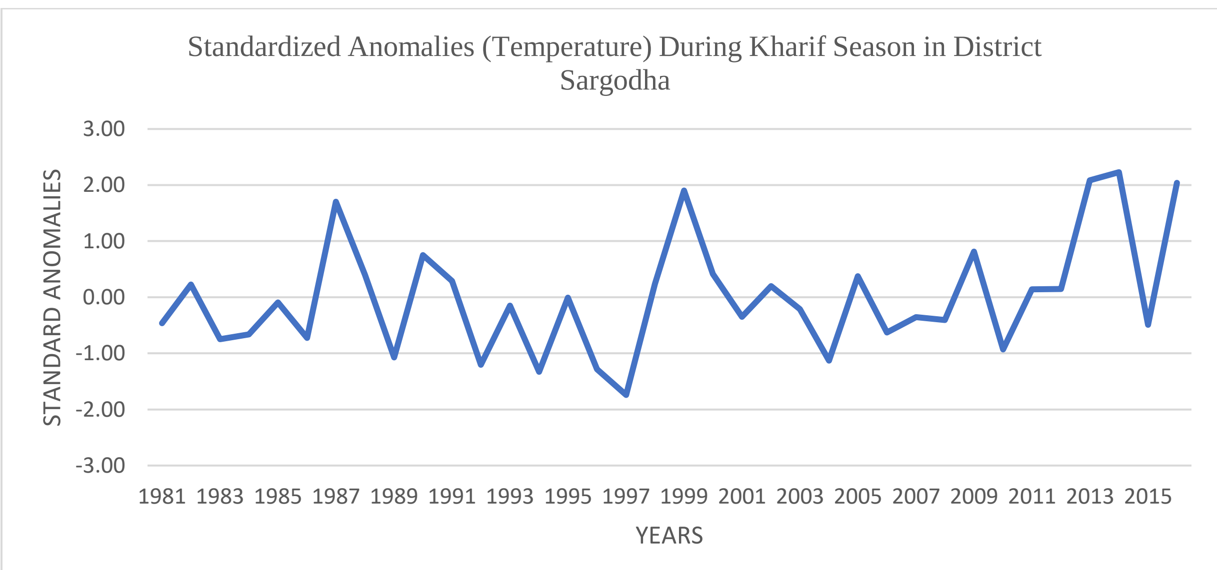


Figure 37: Standardized Anomalies (Temperature) During Kharif Season in District Larkana

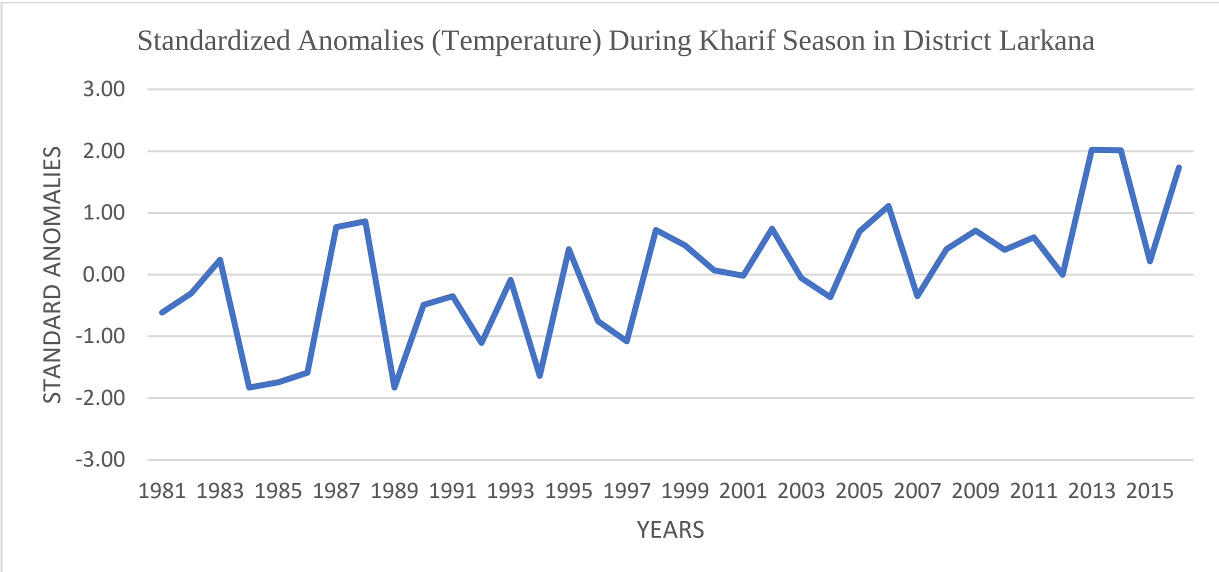


Figure 38: Standardized Anomalies (Temperature) During Kharif Season in District Mirpur Khas

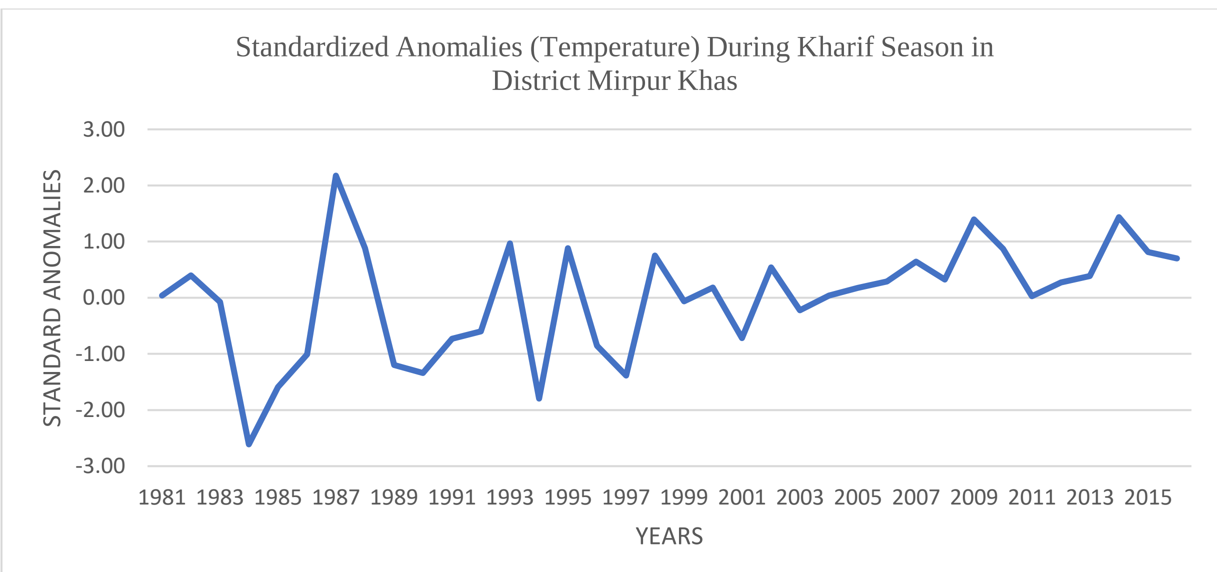


Figure 39: Standardized Anomalies (Temperature) During Kharif Season in District Sukkur

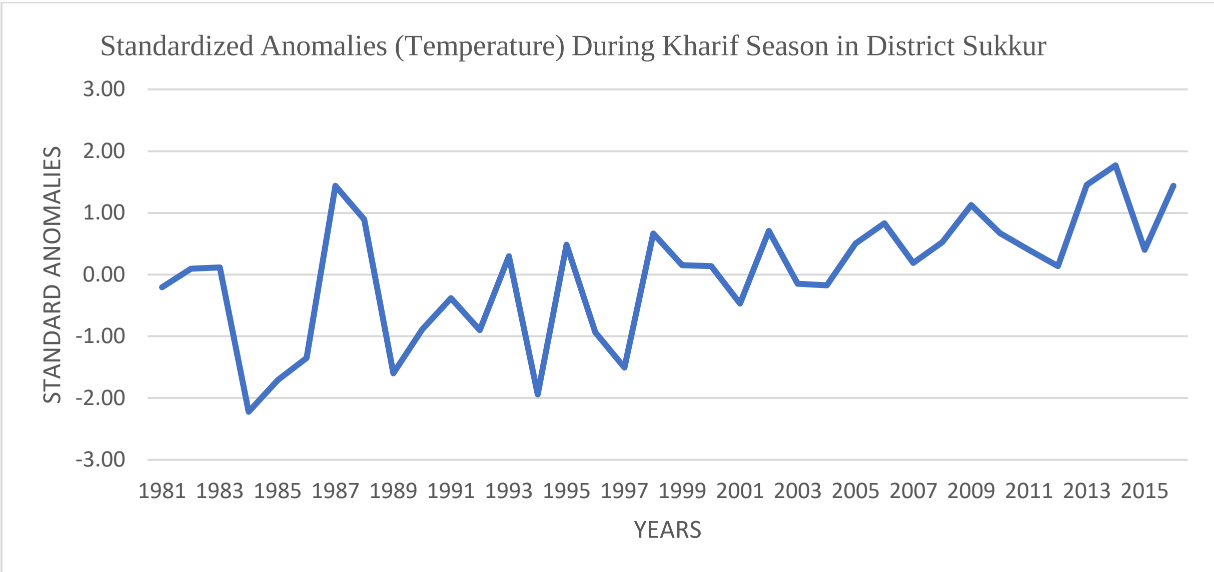


Figure 40: Standardized Anomalies (Temperature) During Rabi Season in Province Northern Areas/Gilgit-Baltistan

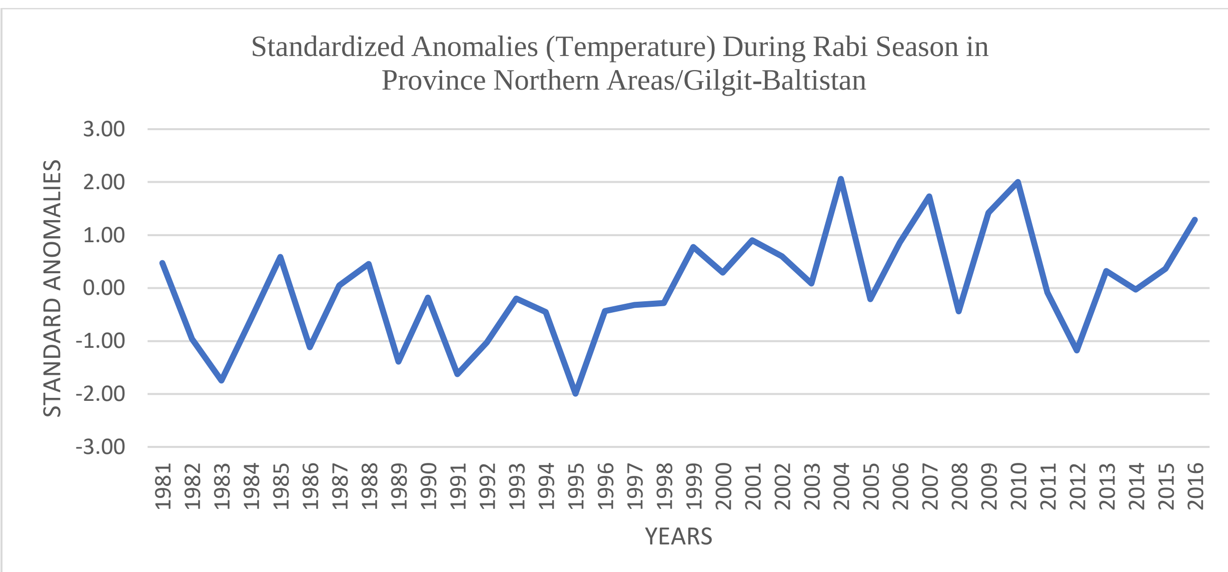


Figure 41: Standardized Anomalies (Temperature) During Rabi Season in Province Punjab

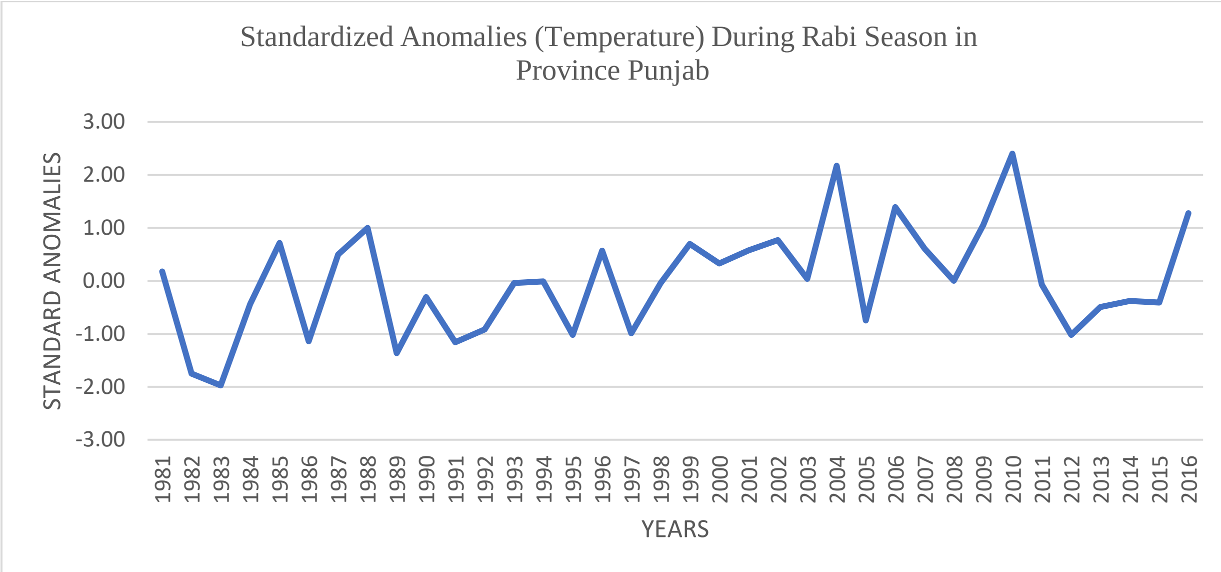


Figure 42: Standardized Anomalies (Temperature) During Rabi Season in Province Sindh

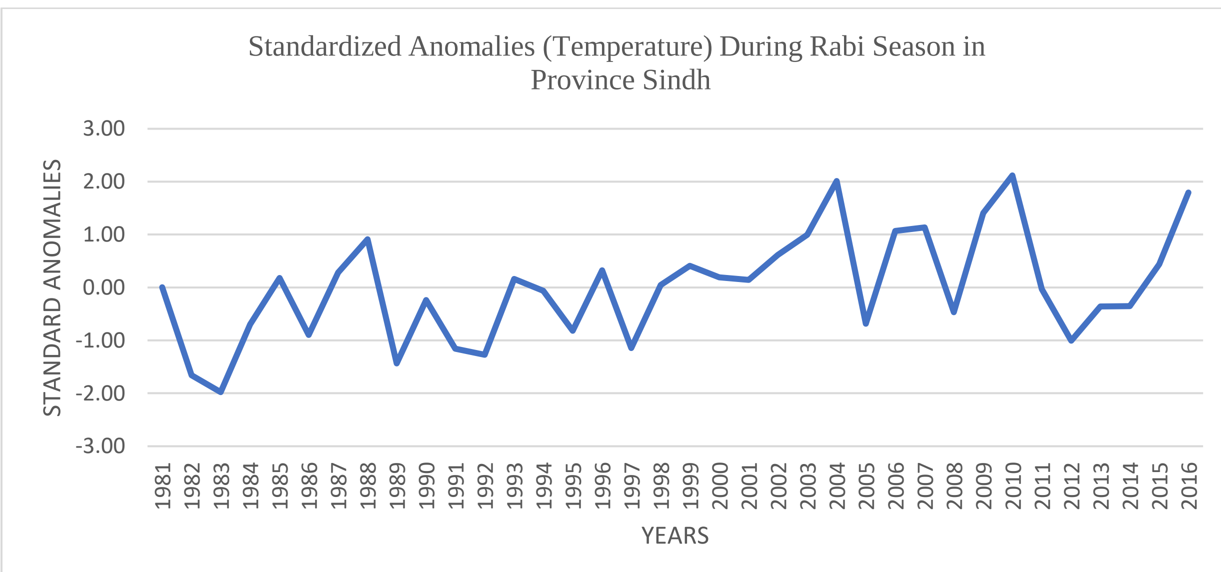


Figure 43: Standardized Anomalies (Temperature) During Rabi Season in District Bahawalpur

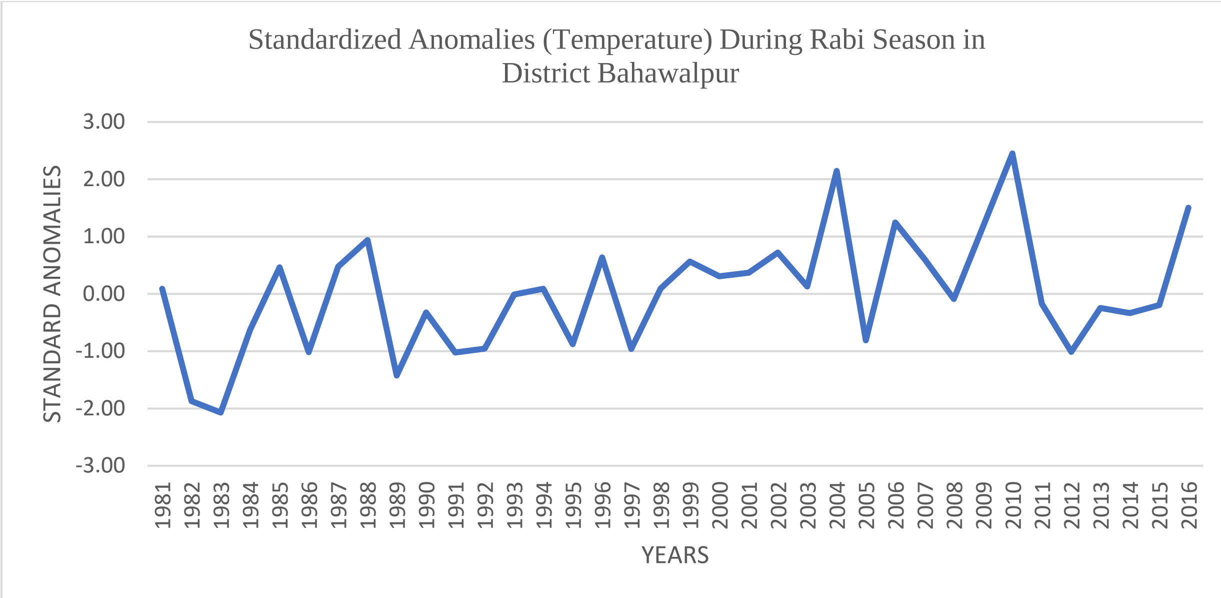


Figure 44: Standardized Anomalies (Temperature) During Rabi Season in District Sargodha

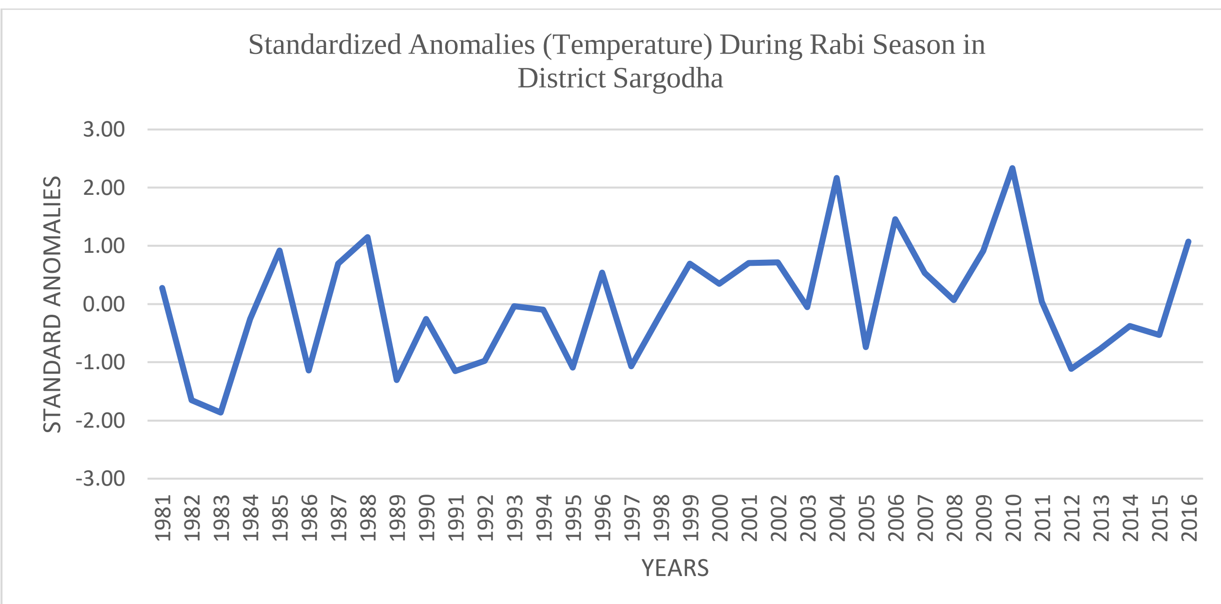


Figure 45: Standardized Anomalies (Temperature) During Rabi Season in District Larkana

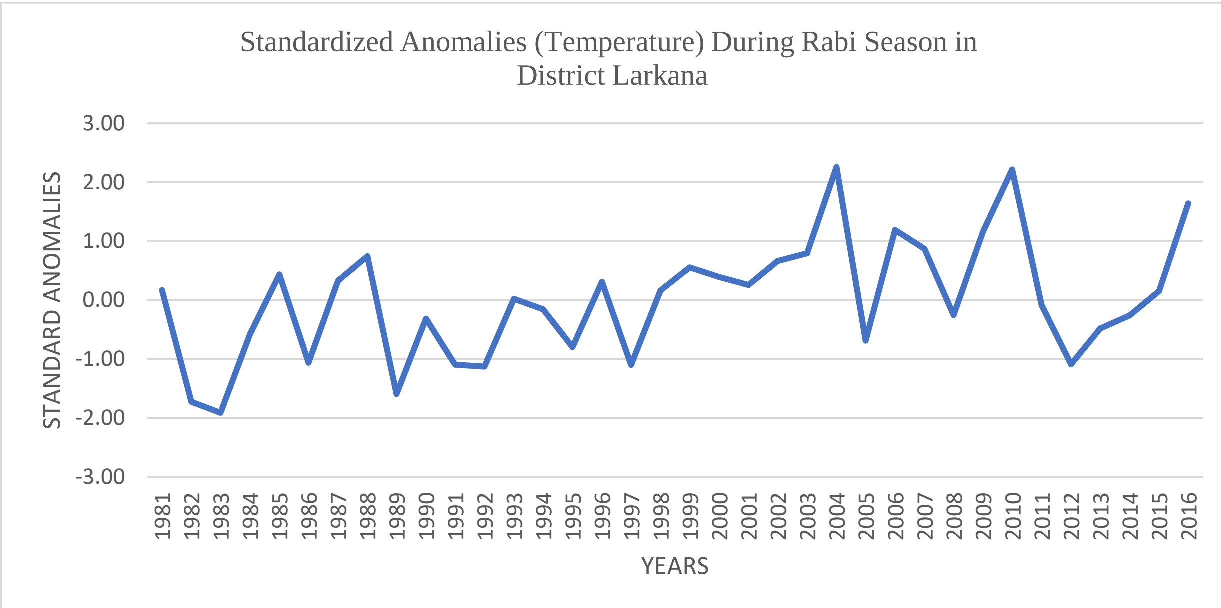


Figure 46: Standardized Anomalies (Temperature) During Rabi Season in District Sukkur

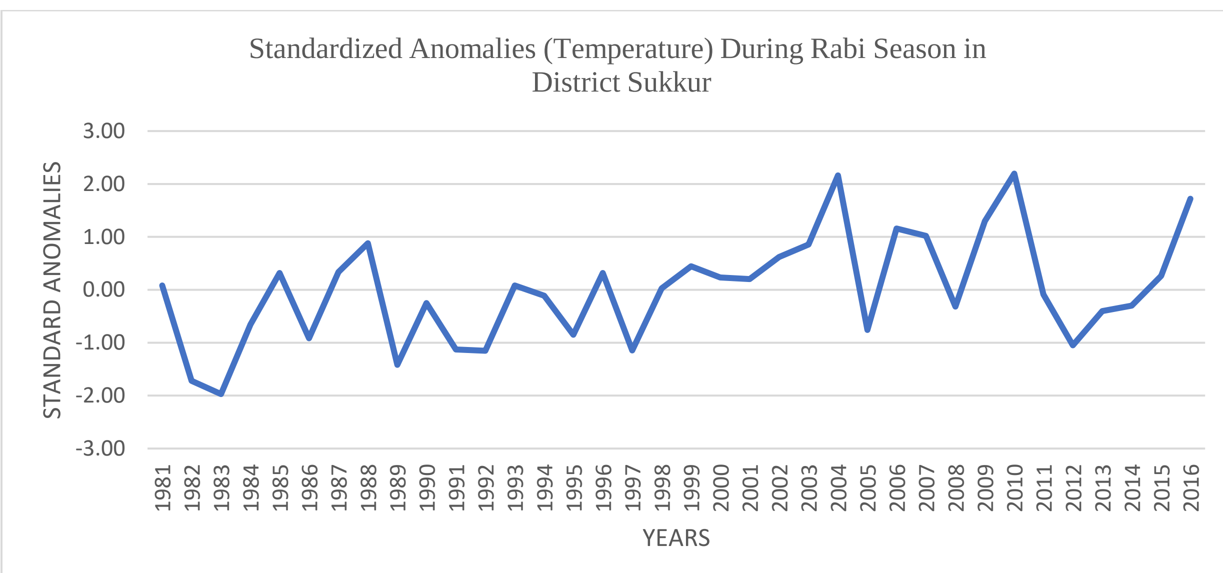


Figure 47: Standardized Anomalies (Temperature) During Rabi Season in District Mirpur Khas

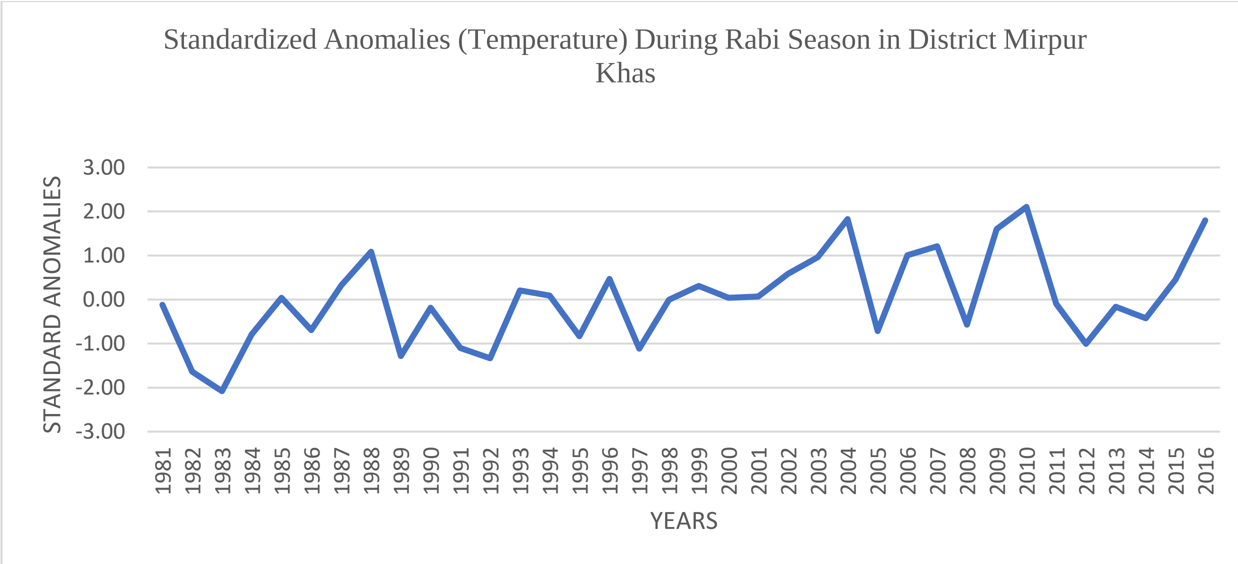


Figure 48: Standardized Anomalies (Maximum NDVI) During Kharif Season in Province Northern Areas/Gilgit-Baltistan

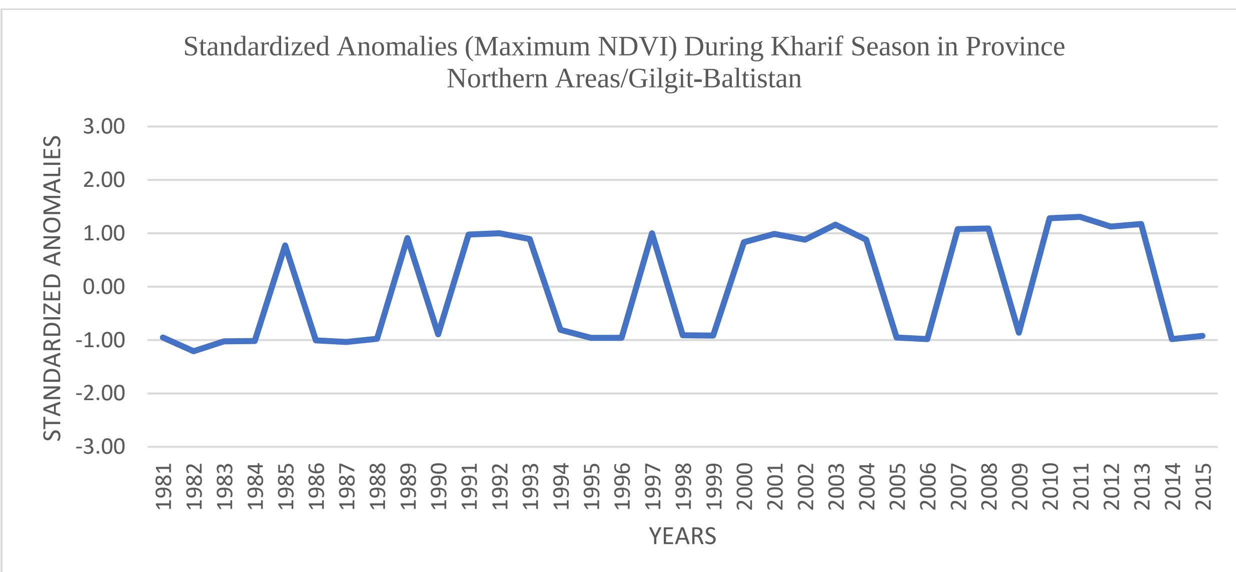


Figure 49: Standardized Anomalies (Maximum NDVI) During Kharif Season in Province Punjab

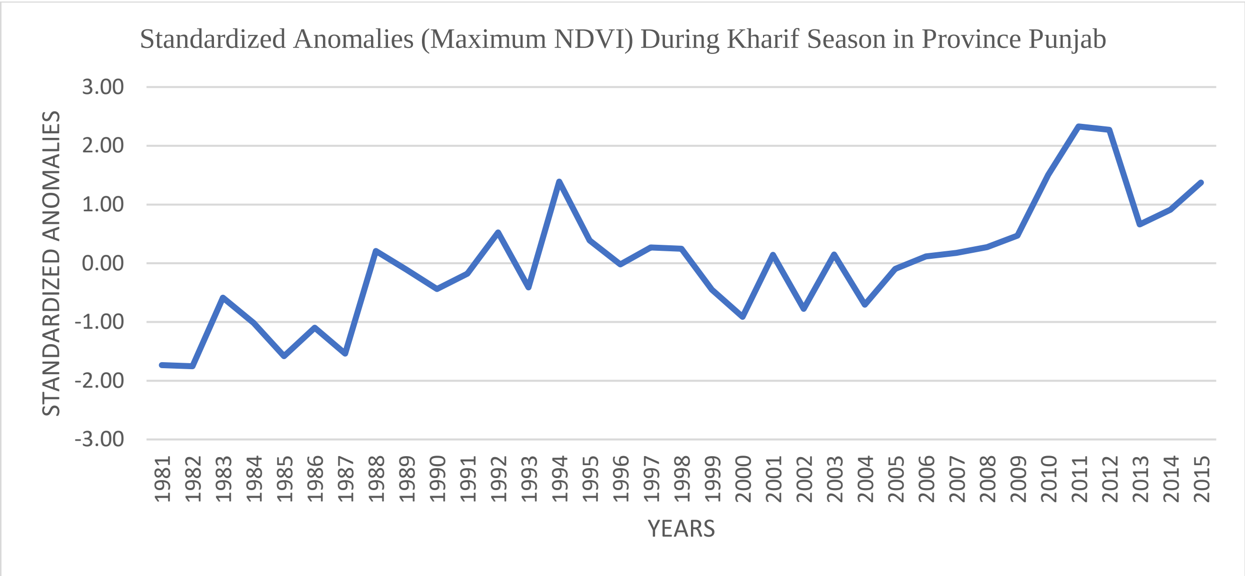


Figure 50: Standardized Anomalies (Maximum NDVI) During Kharif Season in Province Sindh

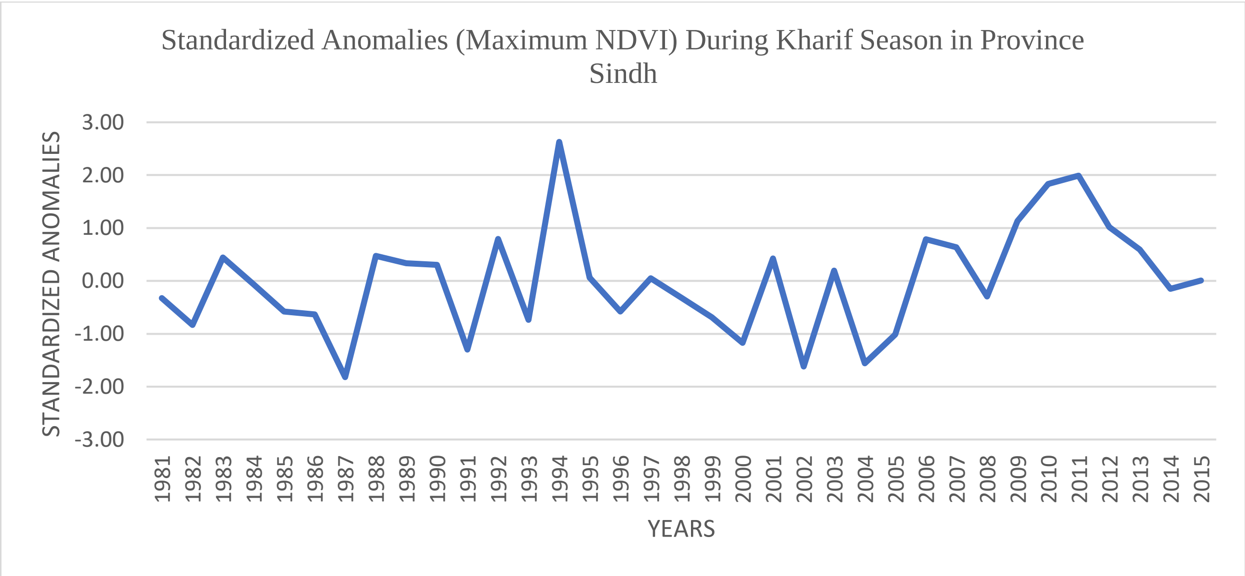


Figure 51: Standardized Anomalies (Maximum NDVI) During Kharif Season in District Bahawalpur

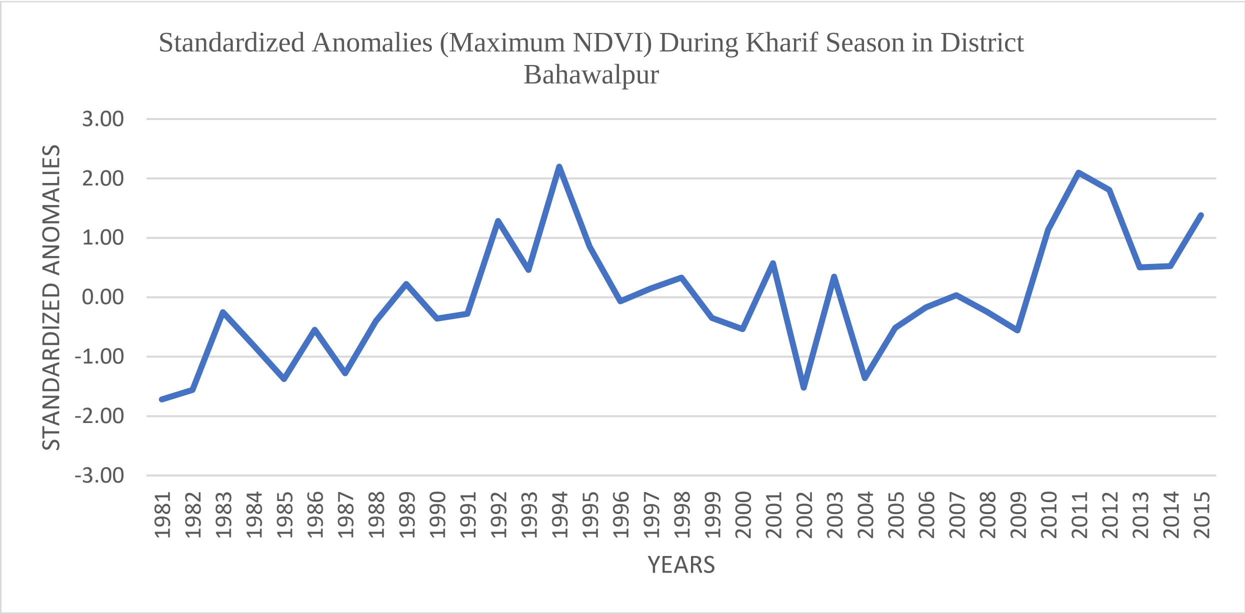


Figure 52: Standardized Anomalies (Maximum NDVI) During Kharif Season in District Sargodha

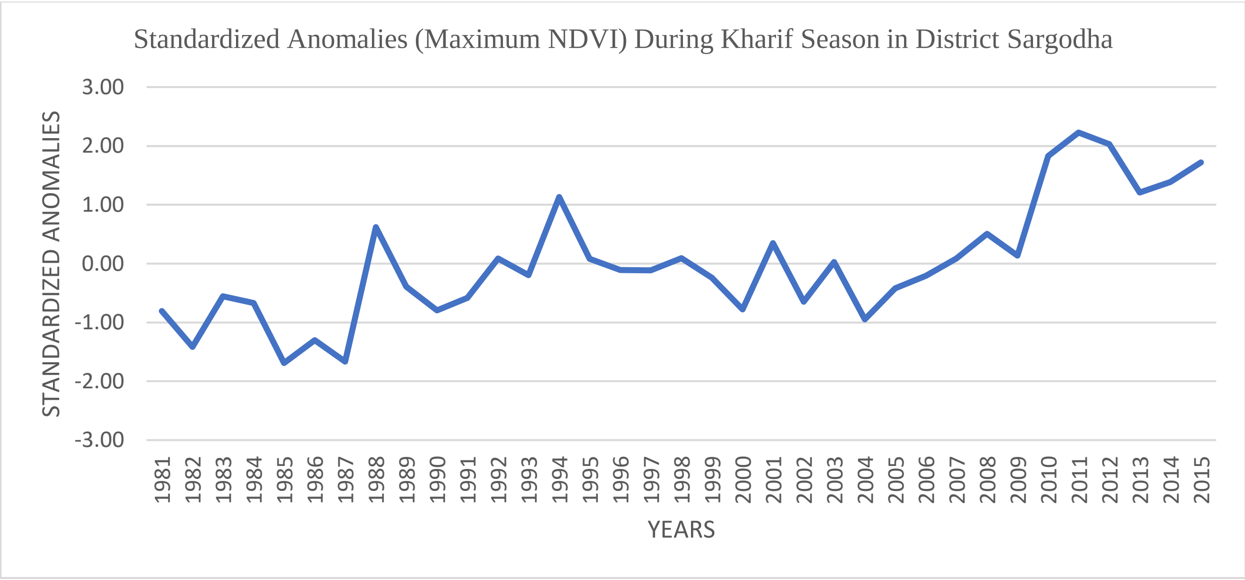


Figure 53: Standardized Anomalies (Maximum NDVI) During Kharif Season in District Larkana

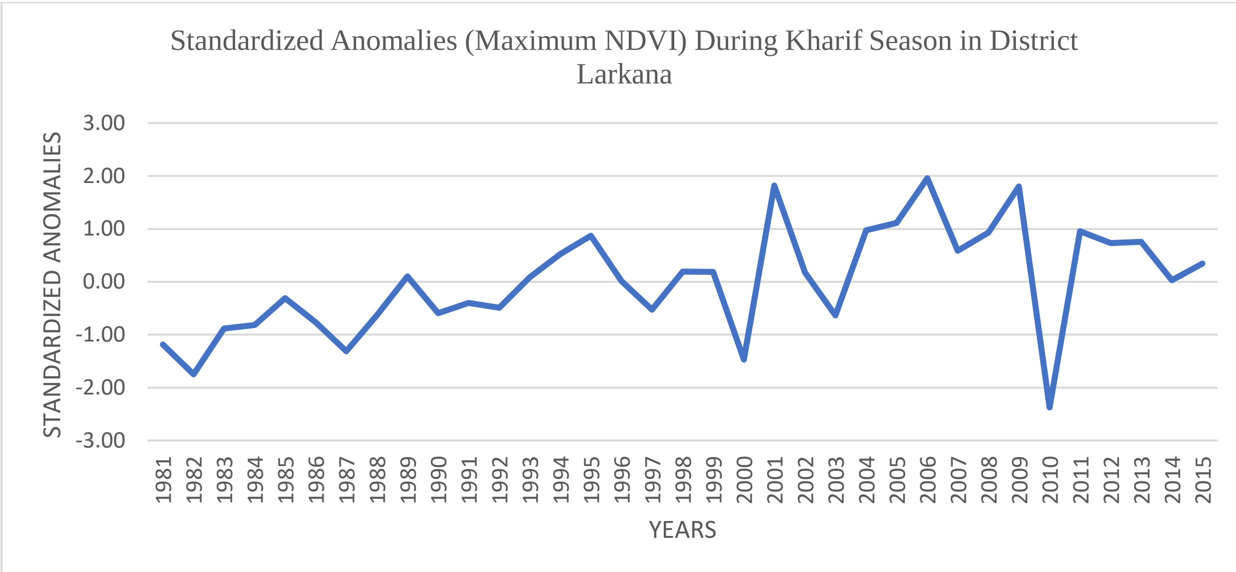


Figure 54: Standardized Anomalies (Maximum NDVI) During Kharif Season in District Mirpur Khas

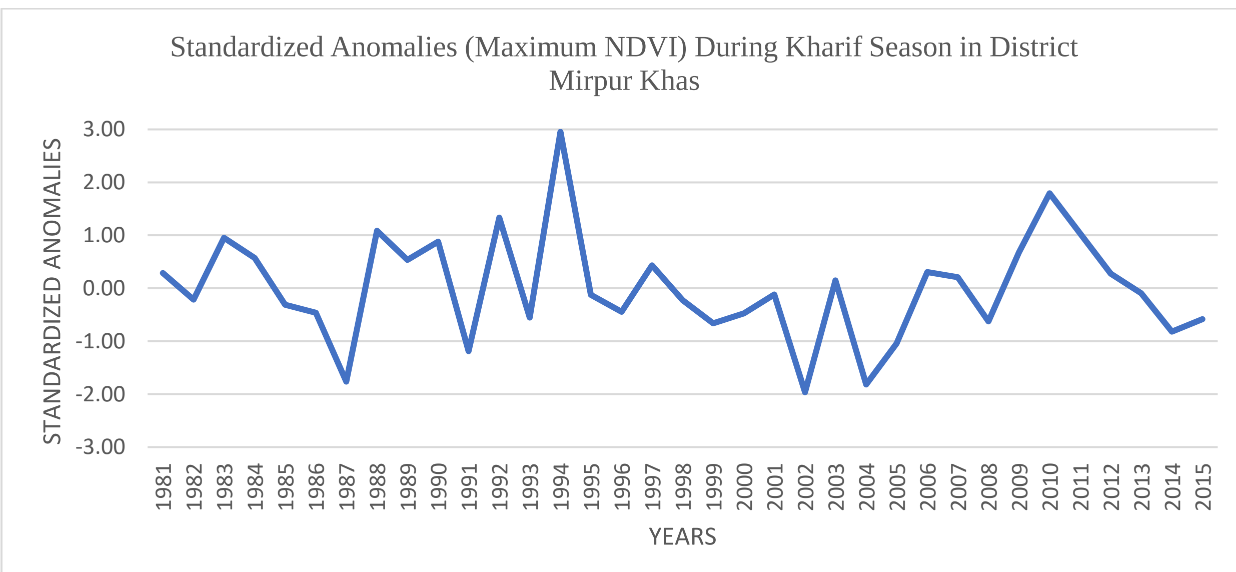


Figure 55: Standardized Anomalies (Maximum NDVI) During Kharif Season in District Sukkur

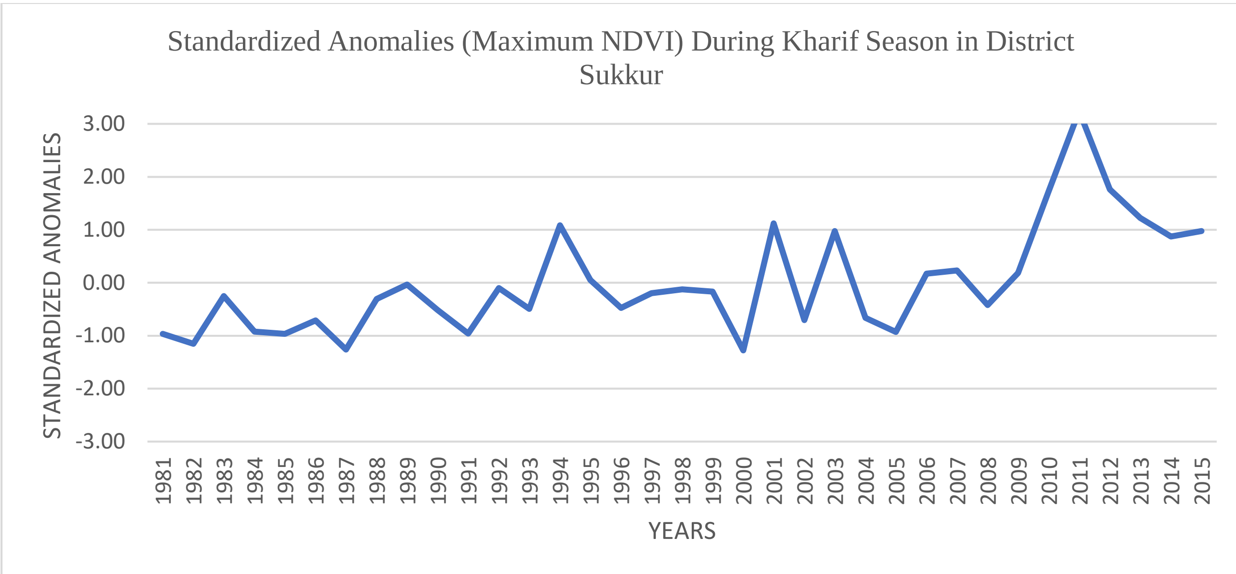


Figure 56: Standardized Anomalies (Median NDVI) During Kharif Season in Province Northern Areas/Gilgit-Baltistan

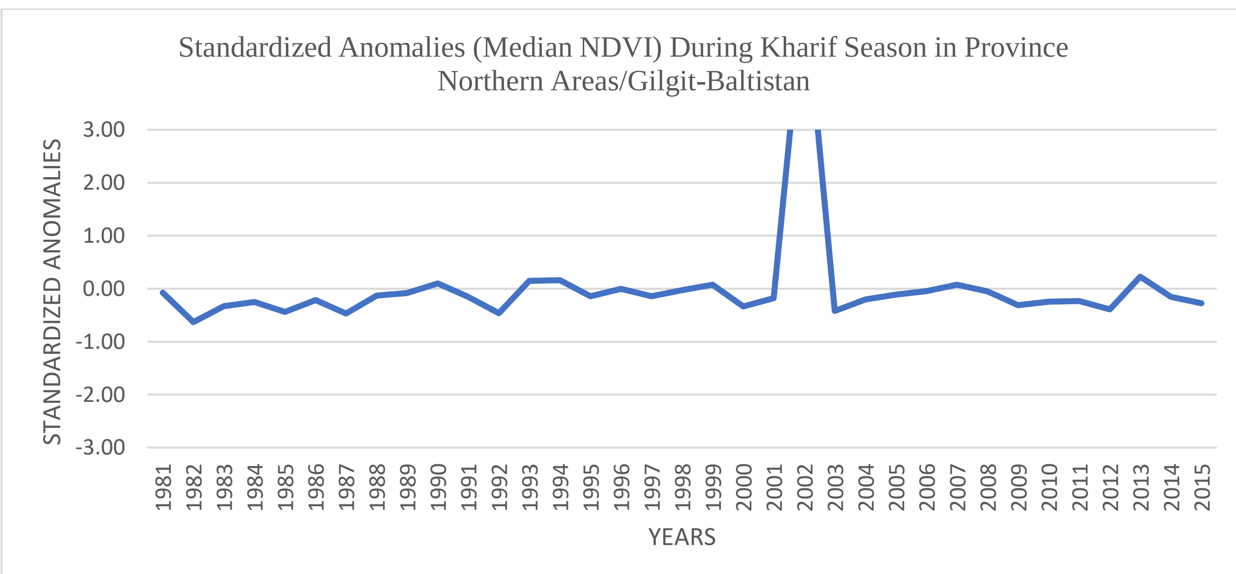


Figure 57: Standardized Anomalies (Median NDVI) During Kharif Season in Province Punjab

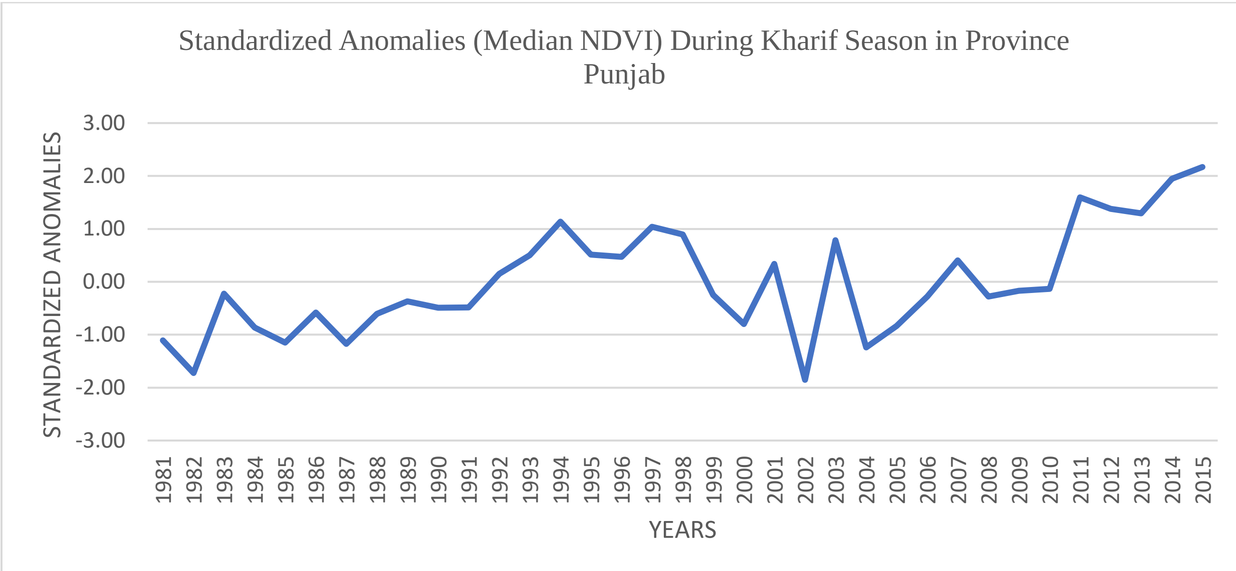


Figure 58: Standardized Anomalies (Median NDVI) During Kharif Season in Province Sindh

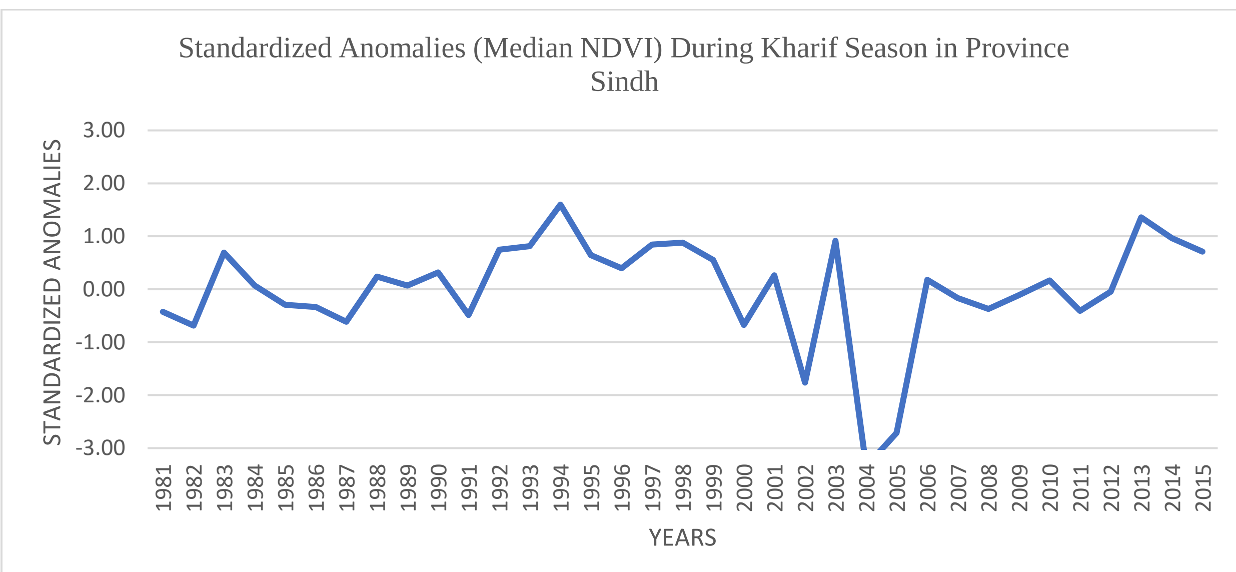


Figure 59: Standardized Anomalies (Median NDVI) During Kharif Season in District Bahawalpur

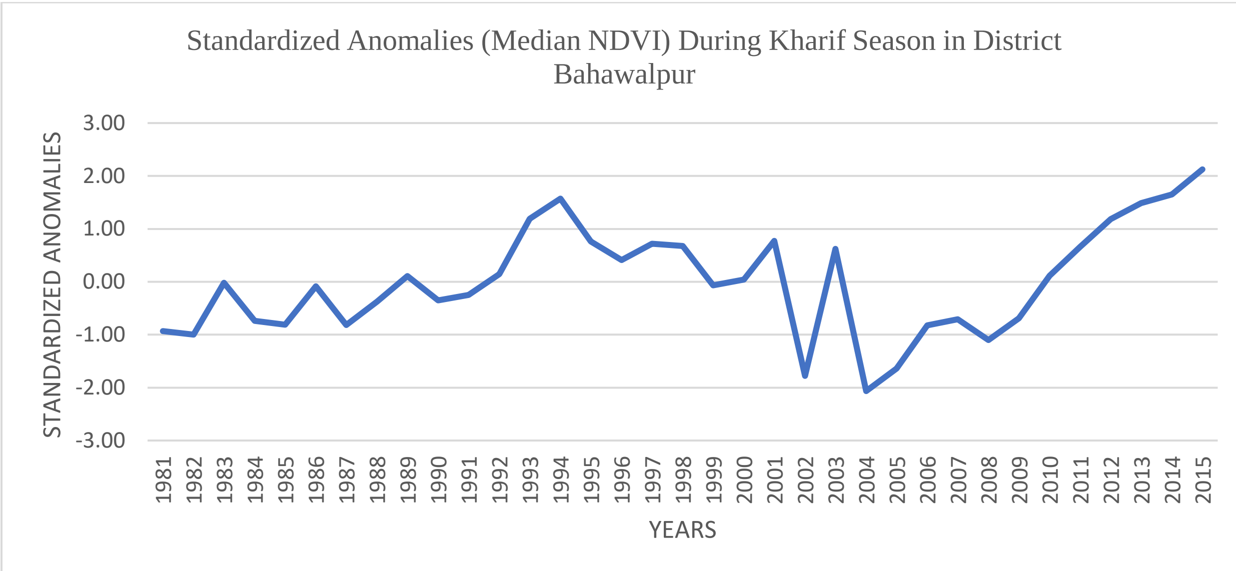


Figure 60: Standardized Anomalies (Median NDVI) During Kharif Season in District Sargodha

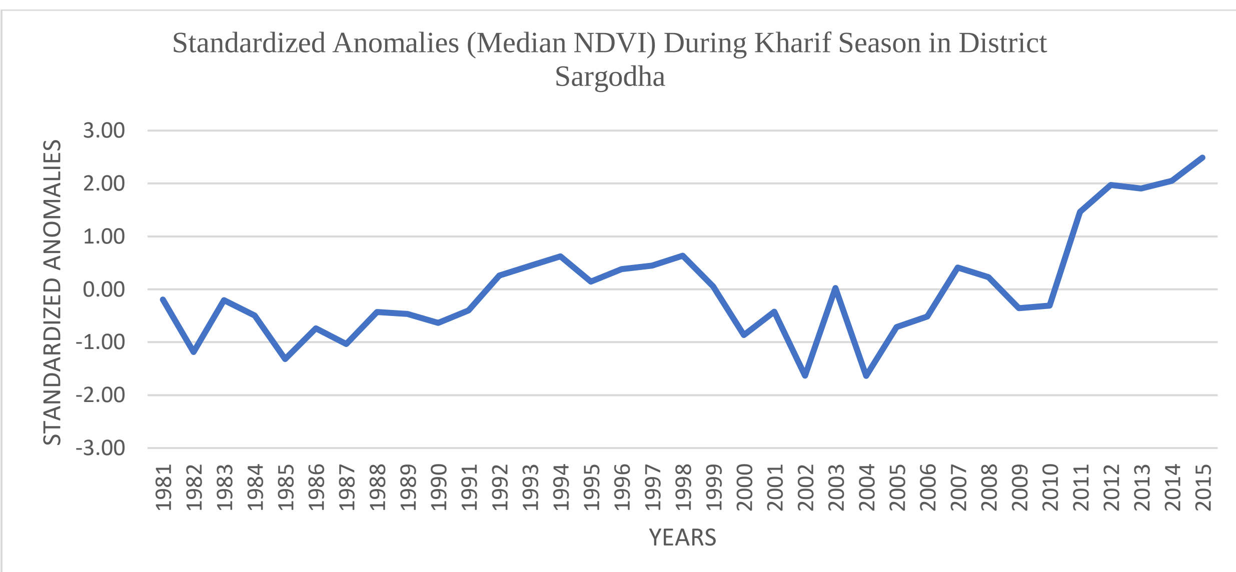


Figure 61: Standardized Anomalies (Median NDVI) During Kharif Season in District Larkana

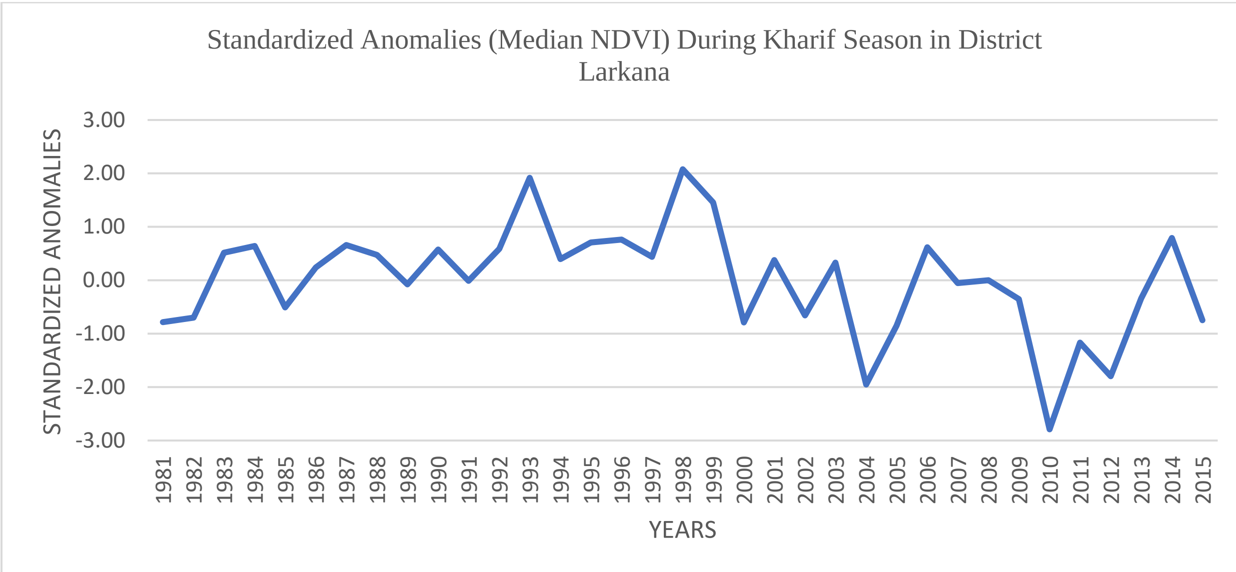


Figure 62: Standardized Anomalies (Median NDVI) During Kharif Season in District Mirpur Khas

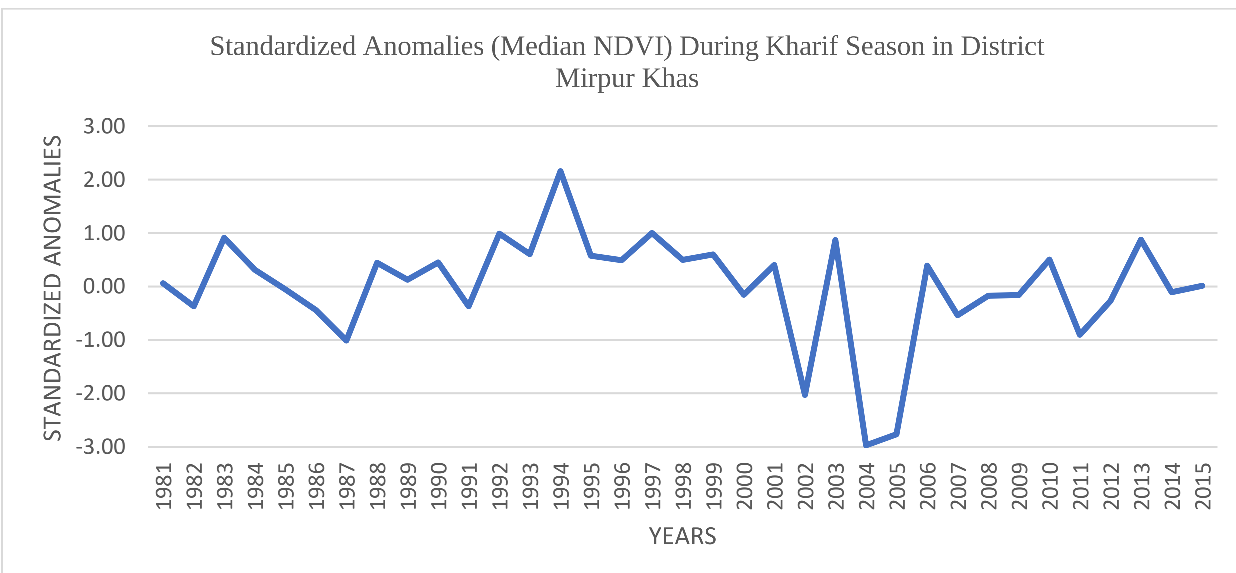


Figure 63: Standardized Anomalies (Median NDVI) During Kharif Season in District Sukkur

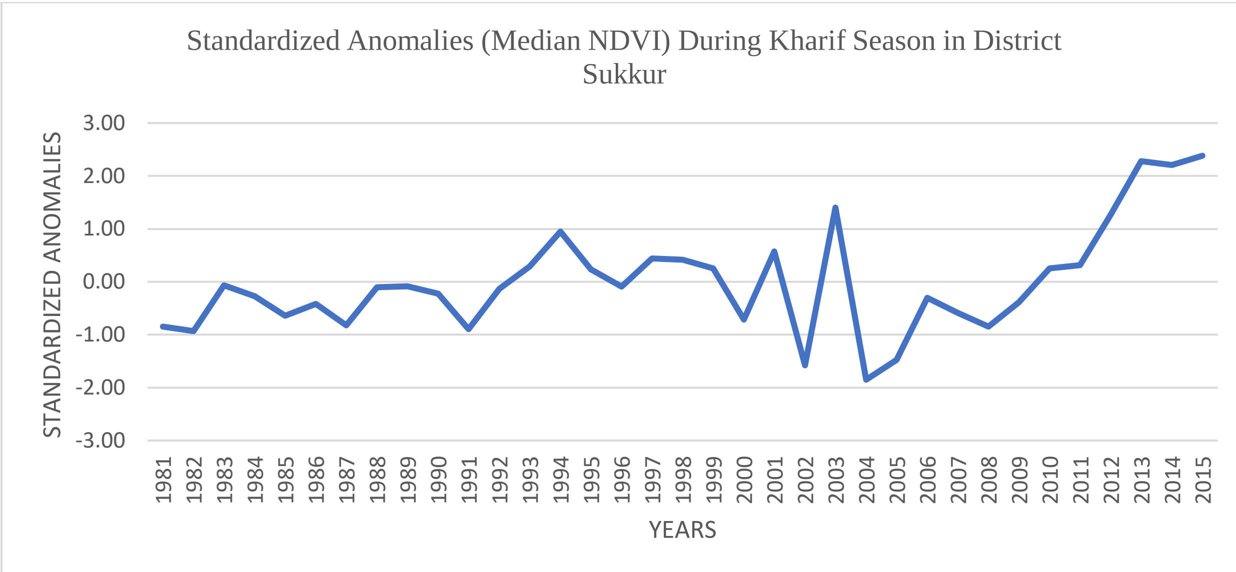


Figure 64: Standardized Anomalies (Maximum NDVI) During Rabi Season in Province Northern Areas/Gilgit-Baltistan

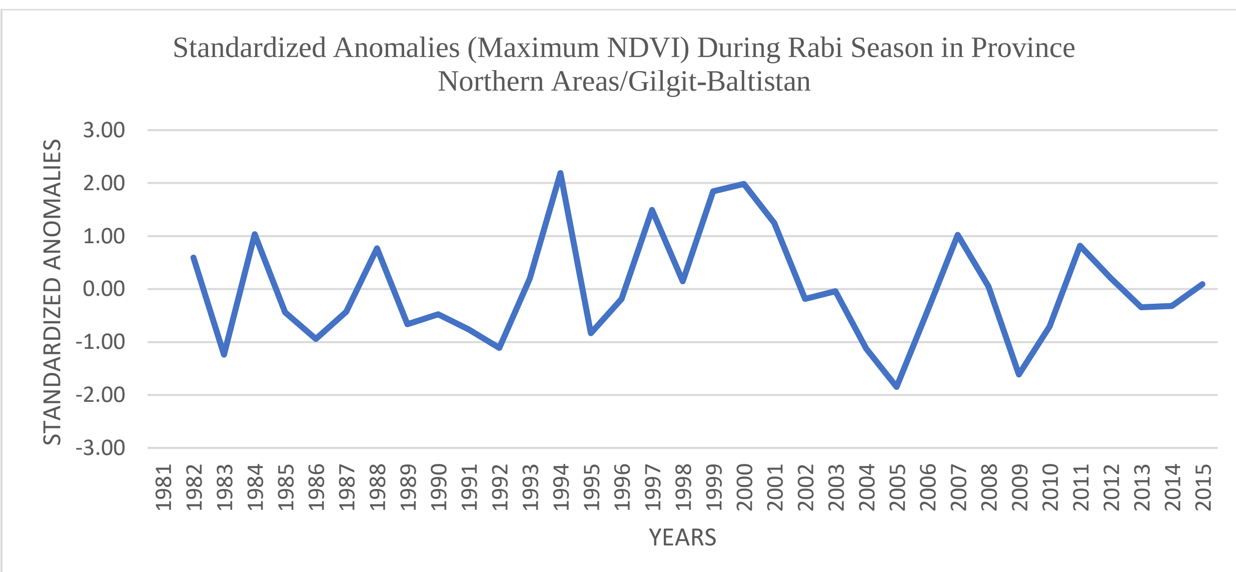


Figure 65: Standardized Anomalies (Maximum NDVI) During Rabi Season in Province Punjab

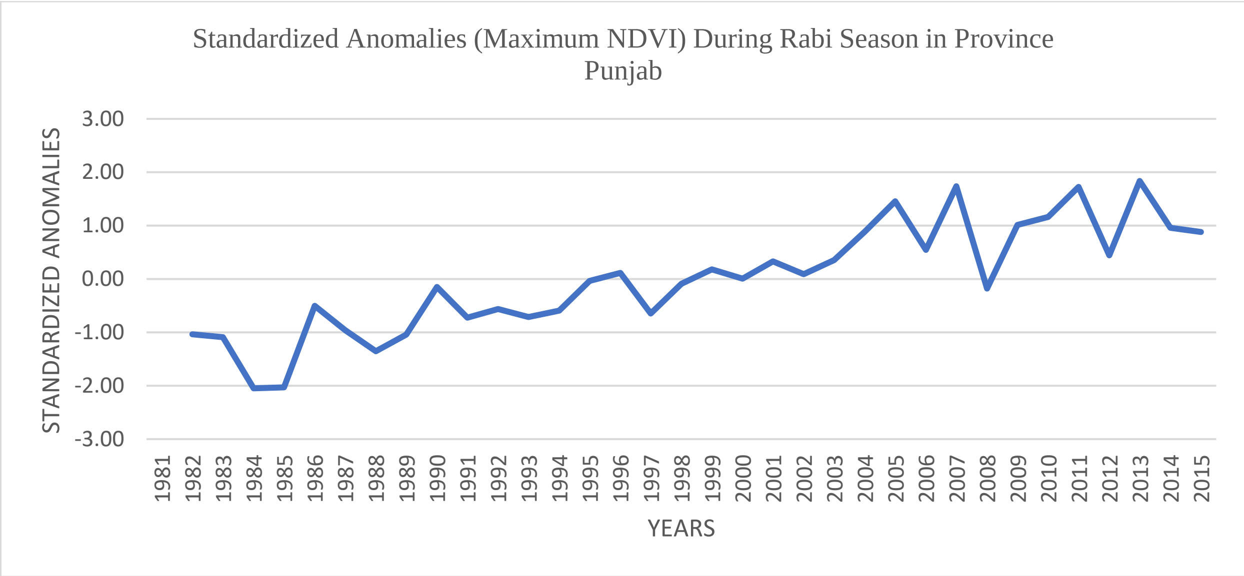


Figure 66: Standardized Anomalies (Maximum NDVI) During Rabi Season in Province Sindh

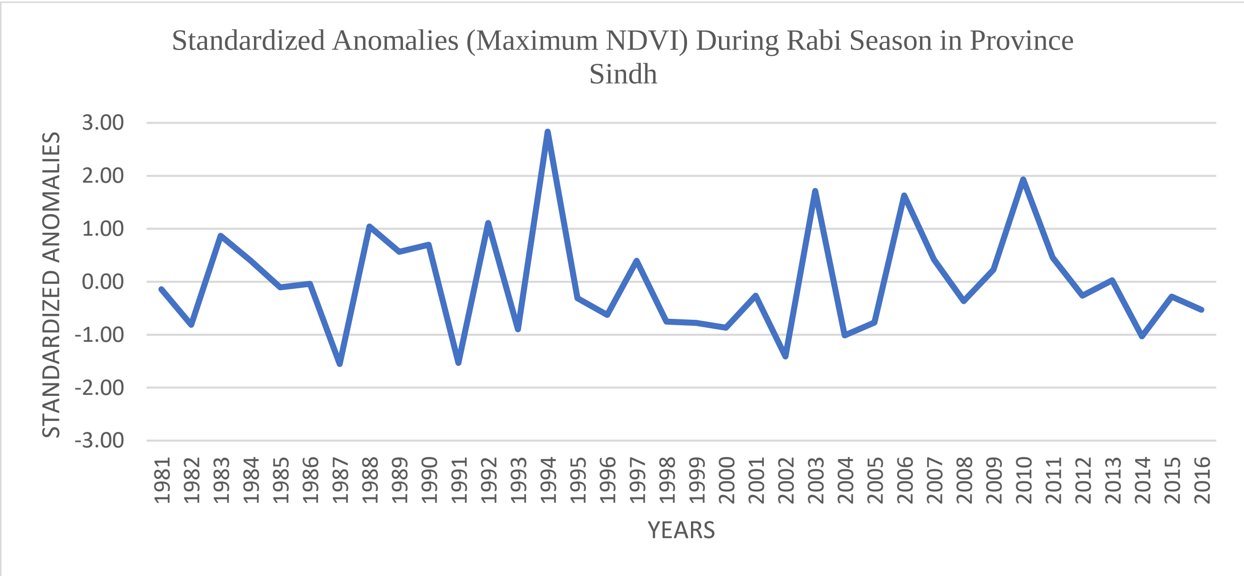


Figure 67: Standardized Anomalies (Maximum NDVI) During Rabi Season in District Bahawalpur

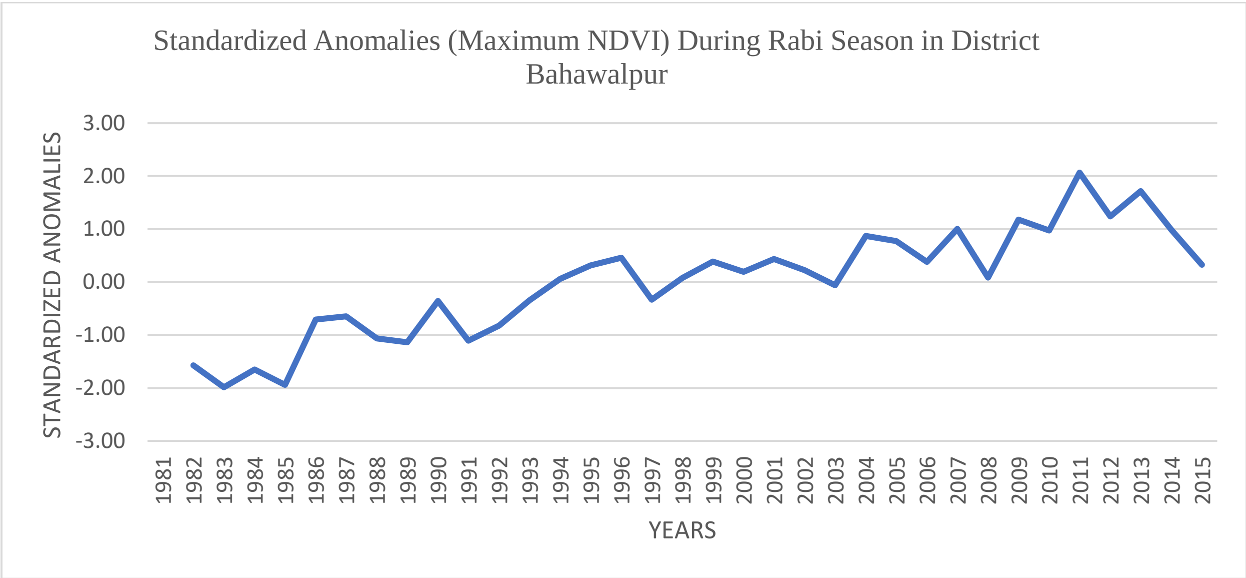


Figure 68: Standardized Anomalies (Maximum NDVI) During Rabi Season in District Sargodha

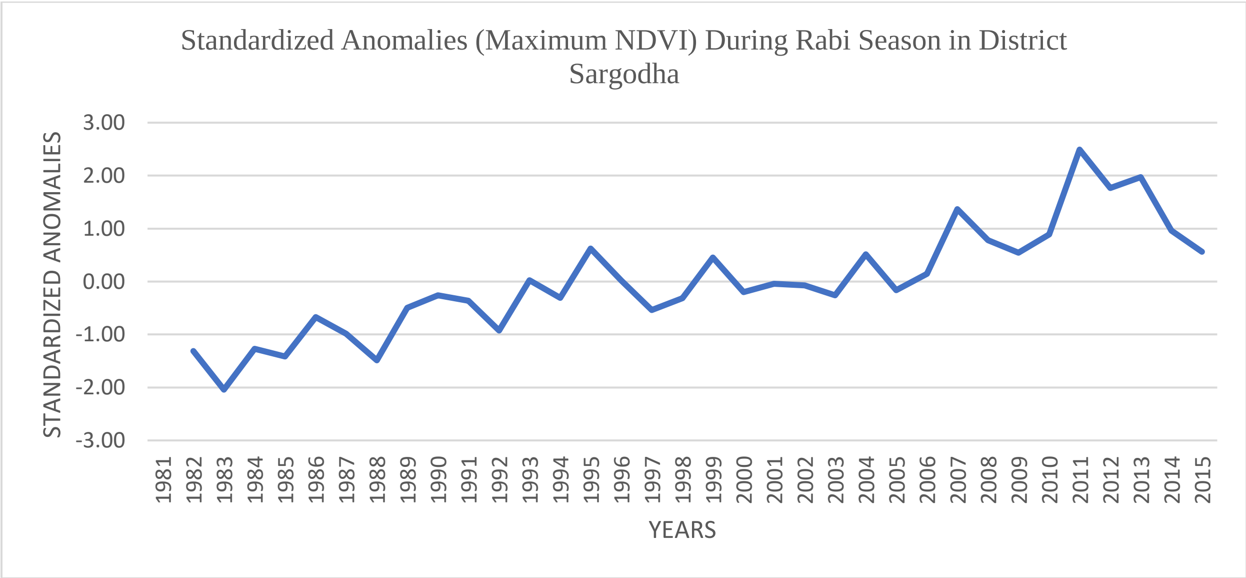


Figure 69: Standardized Anomalies (Maximum NDVI) During Rabi Season in District Larkana

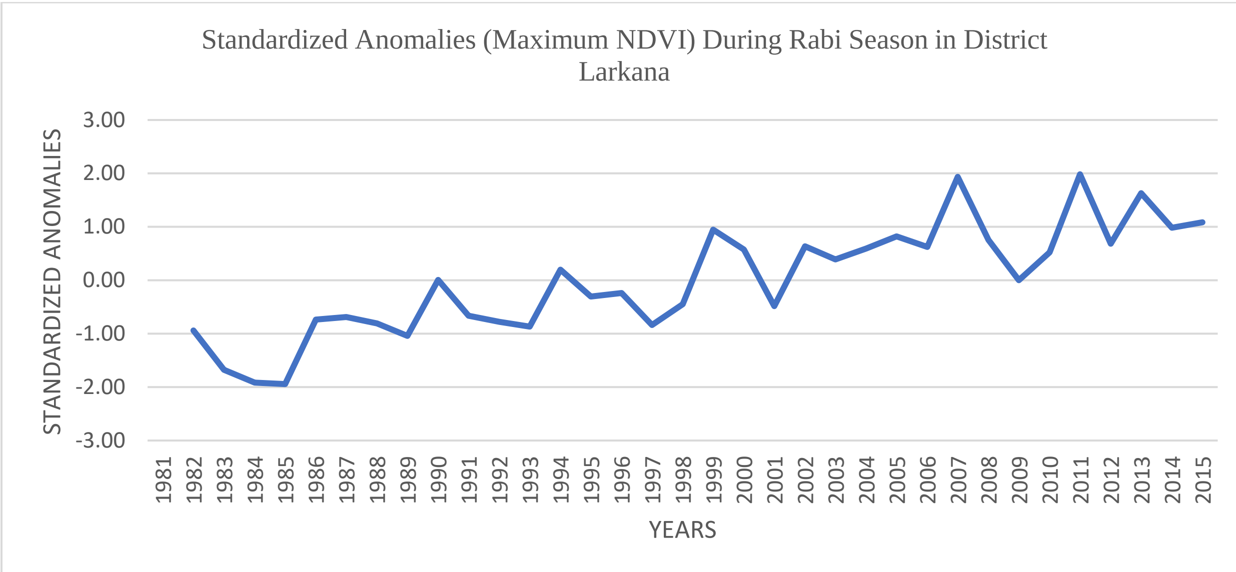


Figure 70: Standardized Anomalies (Maximum NDVI) During Rabi Season in District Mirpur Khas

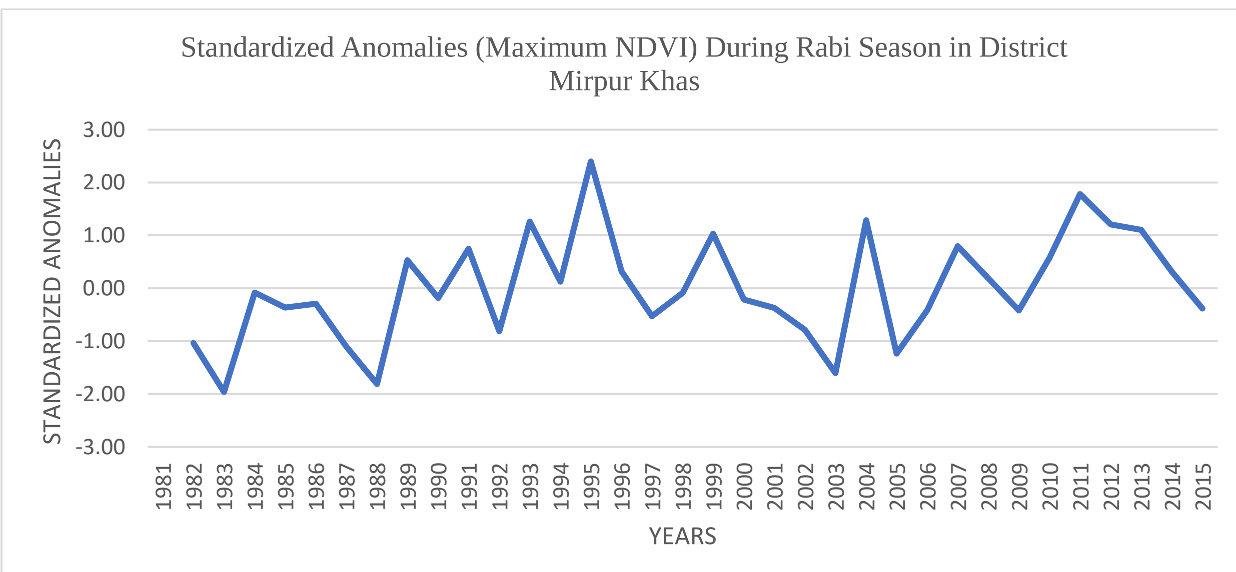


Figure 71: Standardized Anomalies (Maximum NDVI) During Rabi Season in District Sukkur

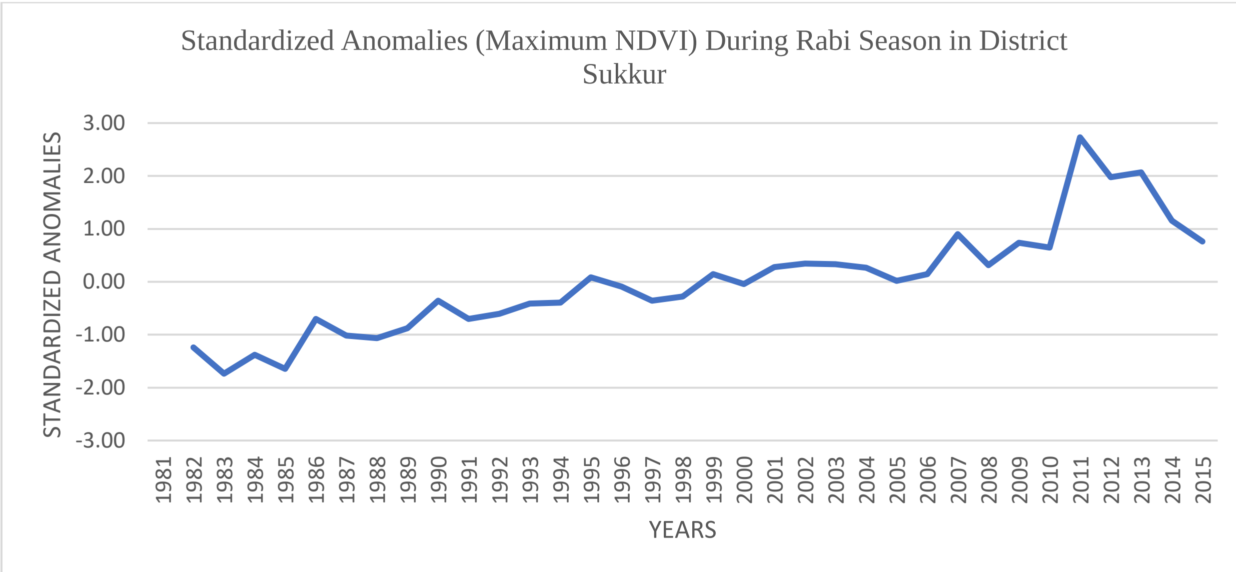


Figure 72: Standardized Anomalies (Median NDVI) During Rabi Season in Province Northern Areas/Gilgit-Baltistan

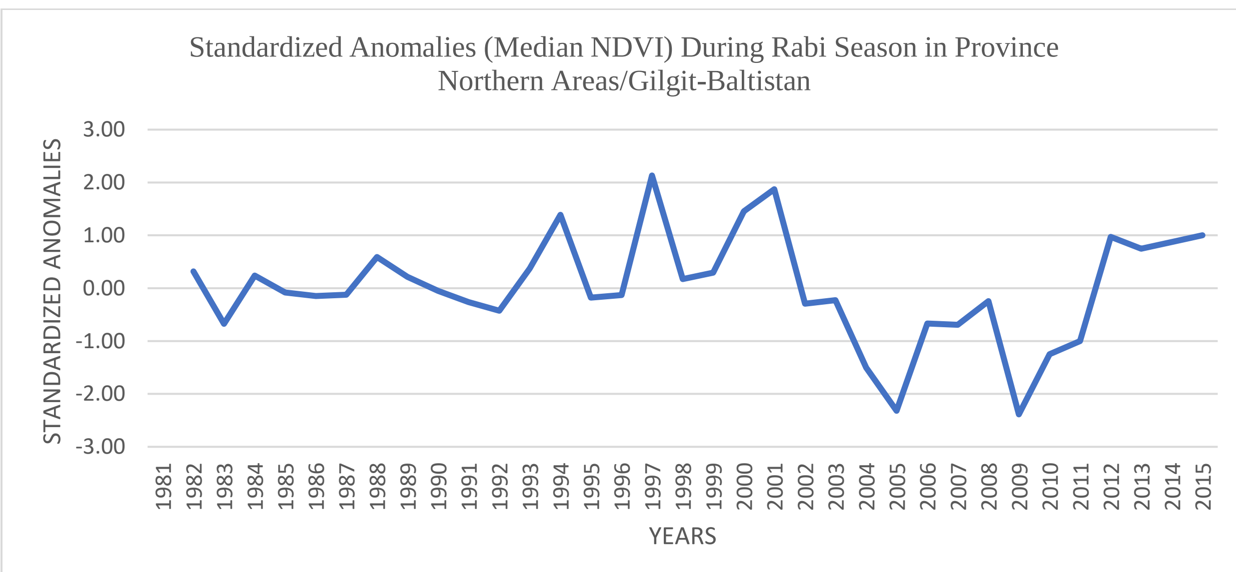


Figure 73: Standardized Anomalies (Median NDVI) During Rabi Season in Province Punjab

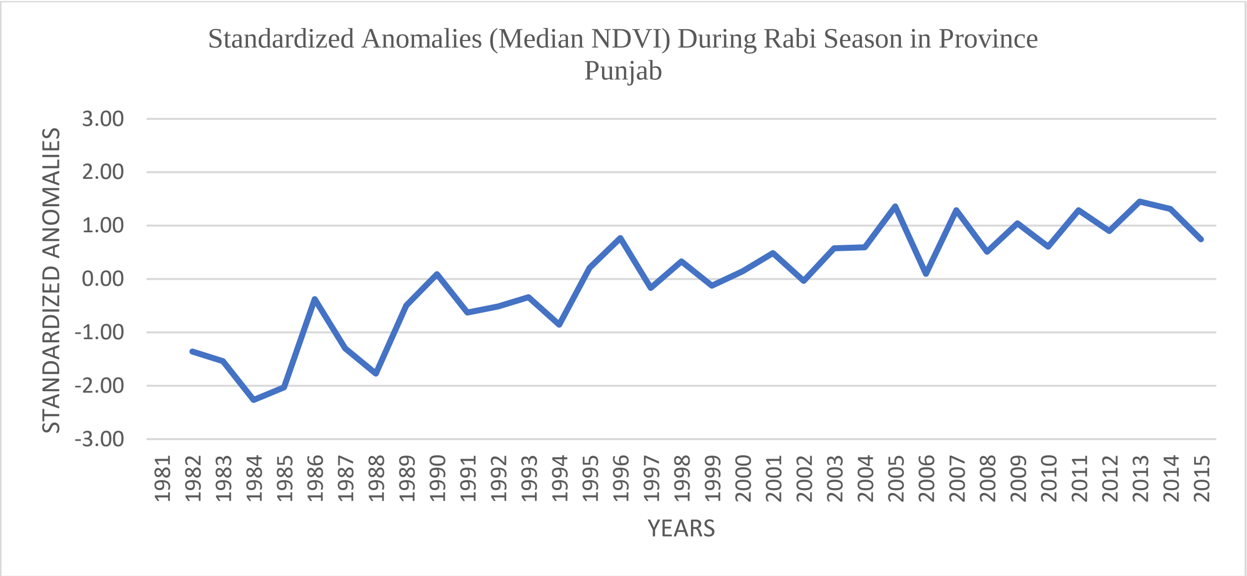


Figure 74: Standardized Anomalies (Median NDVI) During Rabi Season in Province Sindh

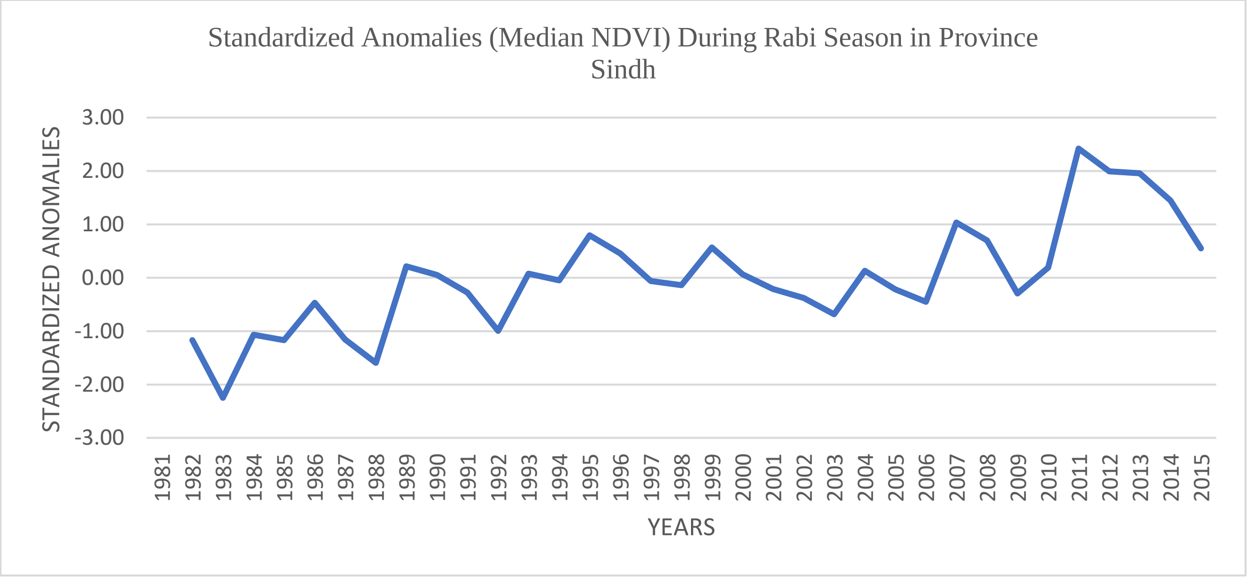


Figure 75: Standardized Anomalies (Median NDVI) During Rabi Season in District Bahawalpur

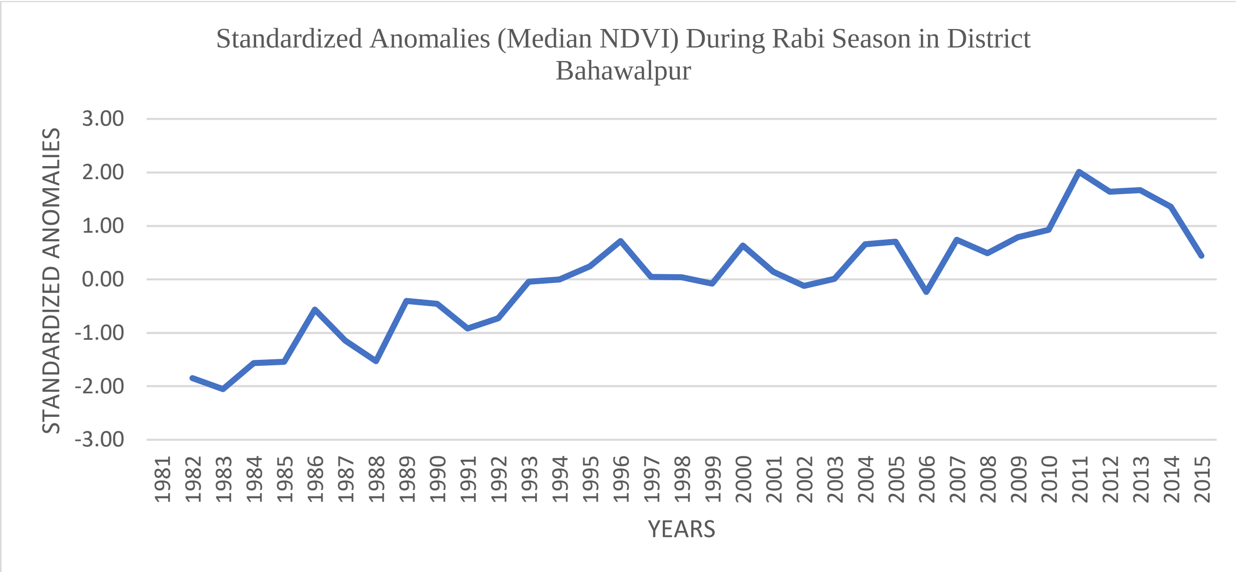


Figure 76: Standardized Anomalies (Median NDVI) During Rabi Season in District Sargodha

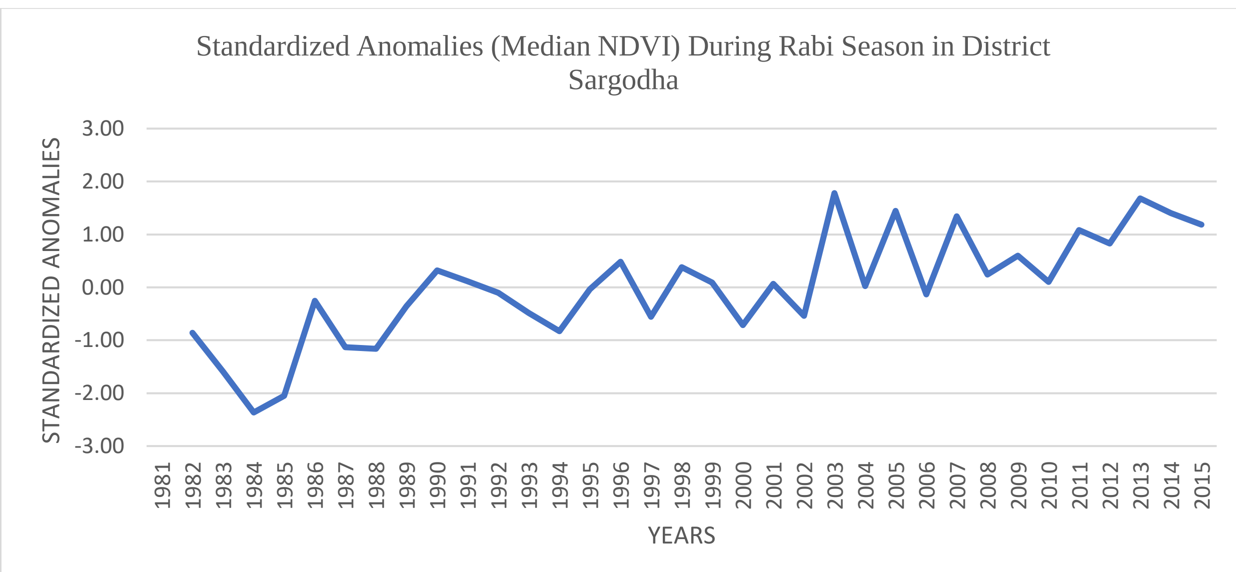


Figure 77: Standardized Anomalies (Median NDVI) During Rabi Season in District Larkana

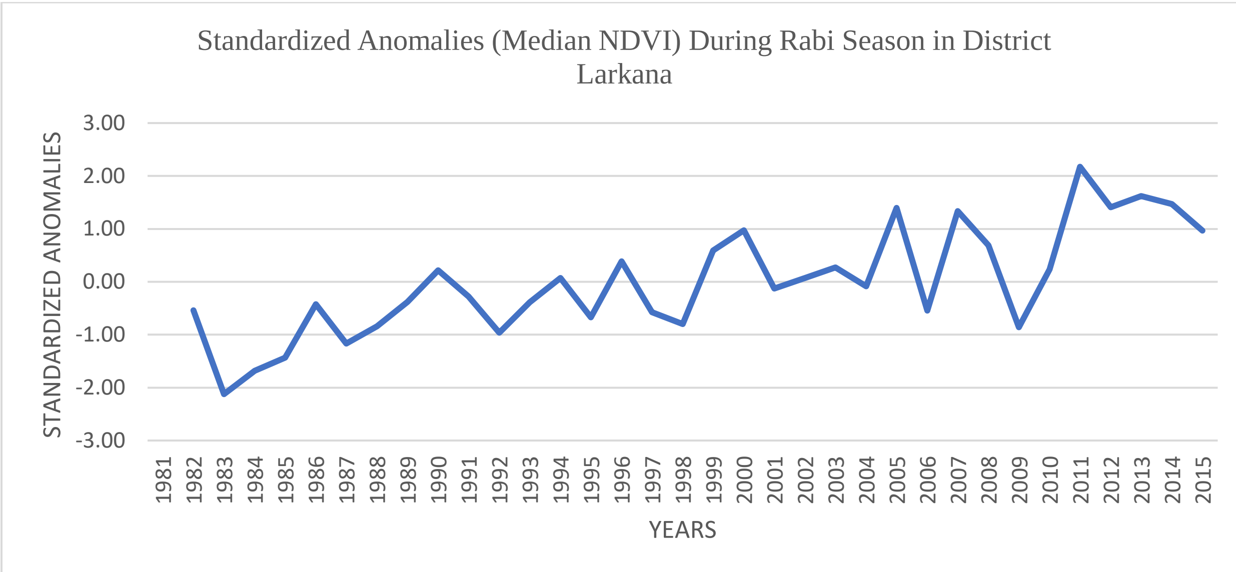


Figure 78: Standardized Anomalies (Median NDVI) During Rabi Season in District Mirpur Khas

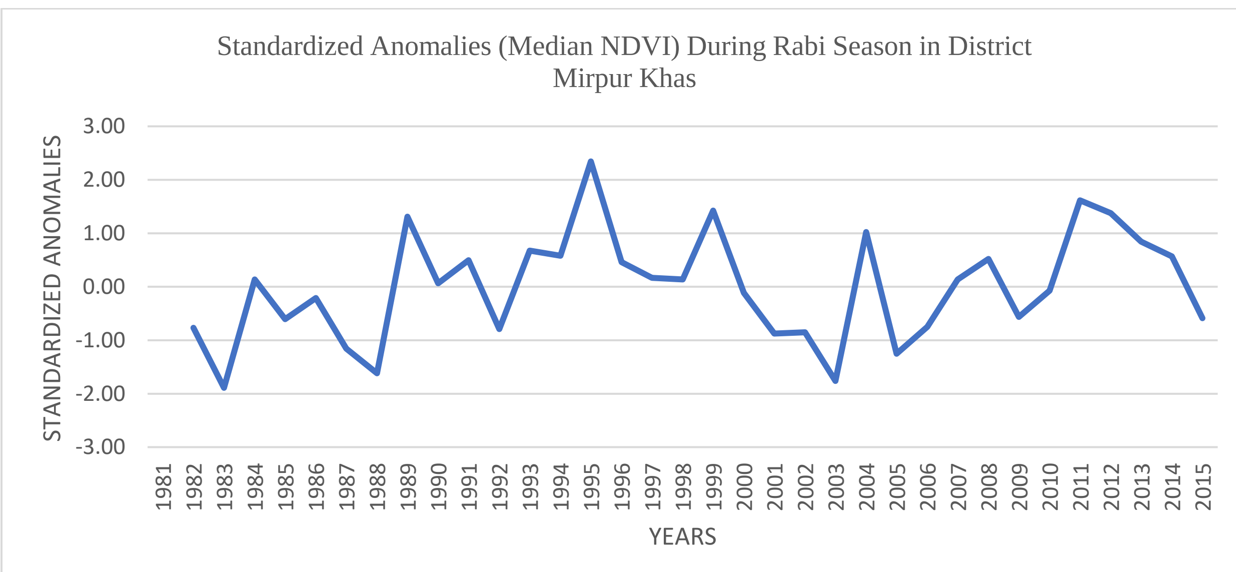
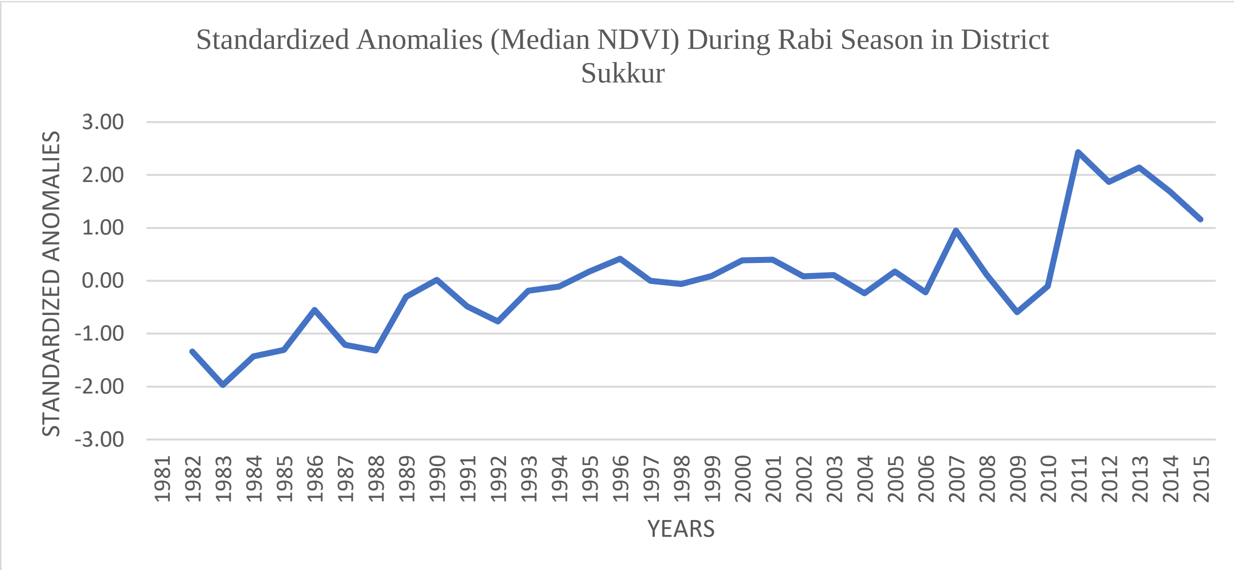


Figure 79: Standardized Anomalies (Median NDVI) During Rabi Season in District Sukkur



On analyzing the standard anomalies chart, it is noticed that most of the districts and provinces have a normal distribution or the values are very close to the mean over a period of 35 years, in terms of temperature and precipitation, for both *Kharif* and *Rabi* seasons. If we were to consider the minor anomalies in the distribution, we can say by looking at the precipitation charts that most areas like provinces of Punjab, Sindh and Northern Areas have many dry years, but very few wet years. The temperature patterns for both *Kharif* and *Rabi* show a normal distribution for all districts and provinces. It either stays close to mean or between +2 and -2 standardized anomaly. This indicates that temperature is not a major contributing factor when we talk about the declining agricultural trend in the hotspot regions.

If we look at the conditions of NDVI in the standard anomaly charts, especially for the hotspots featured in the NDVI maps (see Figures 12-15), like Mirpur Khas, Sukkur, Northern Areas/Gilgit-Baltistan, we notice significant negative anomalies for *Rabi* and *Kharif* Maximum and Median NDVI anomaly charts. With the temperature and precipitation having a normal distribution, we can safely assume that the declining trends in the agriculture for Sukkur, Mirpur Khas or the Northern Areas/Gilgit-Baltistan is caused by the shortage and the mismanagement of the Indus waters. This is because other than the precipitation, Indus is the most important source of agriculture for the farmers.

In the Maximum NDVI *Kharif* charts we can see a constant pattern of negative anomalies for the districts of Mirpur Khas, Sukkur, and the Province of Northern Areas/Gilgit-Baltistan. In the Median *Kharif* charts, we can observe the same downward pattern for NDVI for Provinces of Sindh and Northern Areas/Gilgit Baltistan, and the districts for Larkana and Mirpur Khas.

For the *Rabi* season, we can see the Northern Areas having significant negative anomalies. The District of Bahawalpur showed increase starting from 1996 in the Maximum NDVI, but it is not a very significant increase. One thing common for all the charts is that the increase hardly ever goes above two standard deviations. This mean that even though there are gains in agricultural production, it is not a huge increase. Considering all three factors of NDVI, temperature and precipitation, I can safely assume here, that there are other factors involved in the declining agricultural production of the hotspot areas, like shortage of the Indus waters. The River Indus and its tributaries is the major source of freshwater for many Provinces like Sindh. Thus, it is important to implement better agricultural practices, irrigation and water management techniques to the already dwindling water resource.

In addition to the NDVI data and maps, I have also collected agricultural statistics and charts from Pakistan's Federal Bureau of Statistics to shed some light on how the production of the individual crops have been affected over the years from 1983-2009. In the following figures (Figures 80-97) I have tried to analyze both the province-wise area in hectares and the province-wise production of the crops in tons. I have looked at the major crops grown in Pakistan and which contribute significantly to Pakistan's economy.

If we look at the graphs following (Figures 80-97), we will notice that production of some major crops like Maize, Bajra, Jowar, Barley and Tobacco have declined significantly over the years in Sindh. Although the production of the two major crops, like wheat and rice, look constant in Sindh, and has increased in other provinces, it is still very low considering it from the viewpoint of a global average. "Comparing the yield of wheat and rice crops with world, data shows that the average yield of wheat in Sindh is 3500 kg/ha whereas, in Germany and UK is more than 8000 kg/ha. Similarly, yield of rice crop in Sindh is 3500 kg/ha and in Egypt it is more than 9000 kg/ha and in USA is about 8000 kg/ha (Lashari and Mahesar 2012,8). This is a very important fact supporting the answers to research questions 1 and 2, that the agriculture of Pakistan has been significantly affected over the years.

There is also a tug of war between the provinces of Punjab and Sindh in Pakistan. As Punjab is the upstream province, its water use greatly affects downstream Sindh's availability. Punjab is also a more dominant province both demographically and politically (Magsi and Atif 2012). The province of Punjab justifies its use of water as the upper riparian on the theory of territorial sovereignty, which states that any state can use the watercourse within its borders as needed, without concerning itself about the downstream riparian (Magsi and Atif 2012). While there exists a huge body of literature on the India-Pakistan water dispute, very little is mentioned about the internal water conflicts between the different provinces in Pakistan. Sindh gets much less than its allocated water share. This has created a huge agricultural and social crisis in Sindh. Political groups in Sindh claim that other provinces in Pakistan are stealing their right to water (Magsi and Atif 2012). "This also includes opposition towards the building of large and small dams/reservoirs upstream to control the flow of water. Sindh, being at the tail-end of the Indus, anticipates that these disputes will lead to even more limited supplies of water (Magsi and Atif 2012, 383). The Indus River is the main source of freshwater in Sindh and most of the province is formed due to the accumulation of silt, which is deposited by the Indus on its banks and in the delta before it flows into the Arabian sea in its final stage. This freshwater, and the delta in turn also sustain the livelihood of millions of fishing communities in Sindh (Magsi and Atif 2012).

Figure 80: Province-wise Area Under Wheat Crop

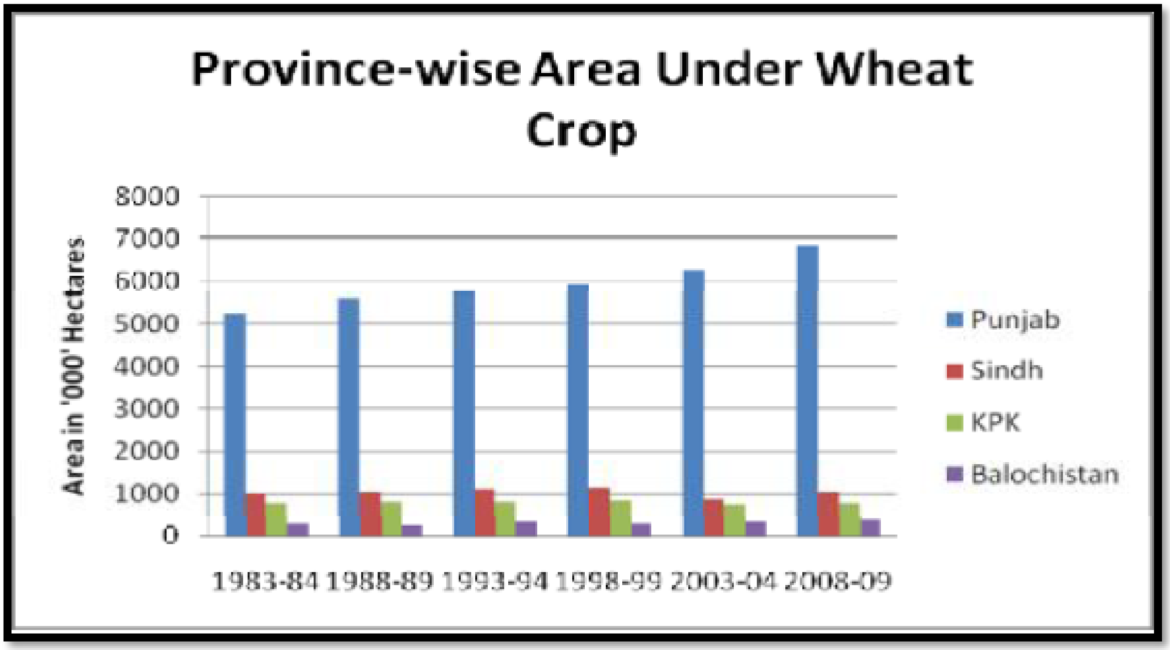


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

As it is clearly seen, Punjab has the highest area under cultivation among all the other provinces. The Indus Basin covers almost the entire area of Punjab and if we look at the precipitation data from the precipitation trends shown earlier (see Figures 8-11), it is clearly evident that Punjab does not enjoy highest of the precipitation among all the provinces of Pakistan. This evidence helps in supporting my answers to Research Question 2 that the agricultural activity is supported mostly by Indus River water and its fluctuations, rather than on the precipitation.

Figure 81: Province-wise Production of Wheat Crop

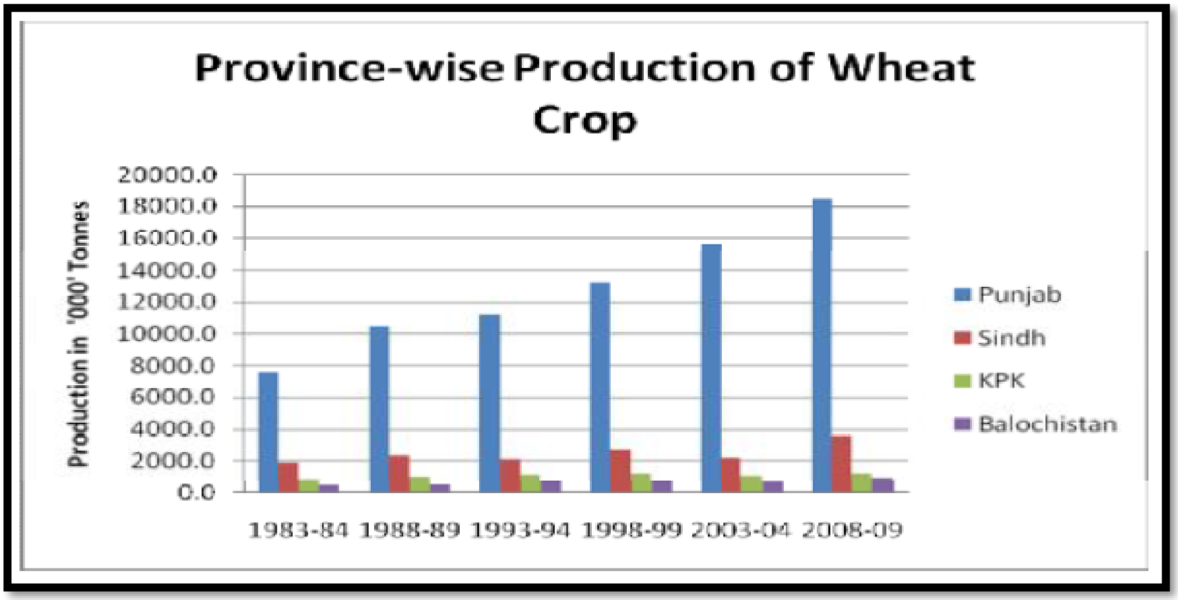


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 82: Province-wise Area Under Rice Crop

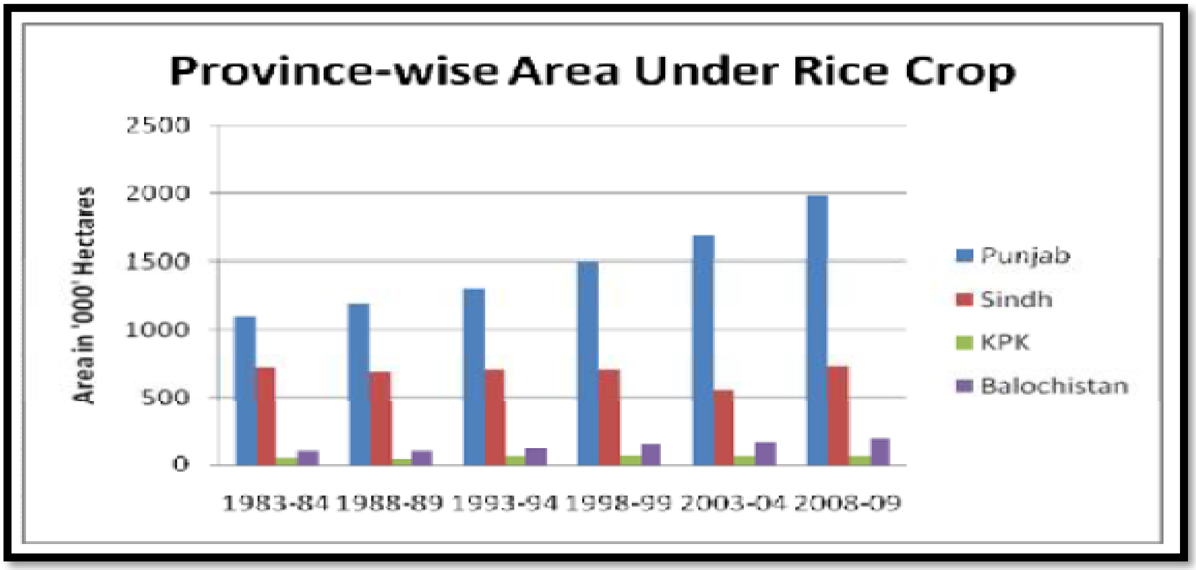


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 83: Province-wise Production of Rice Crop

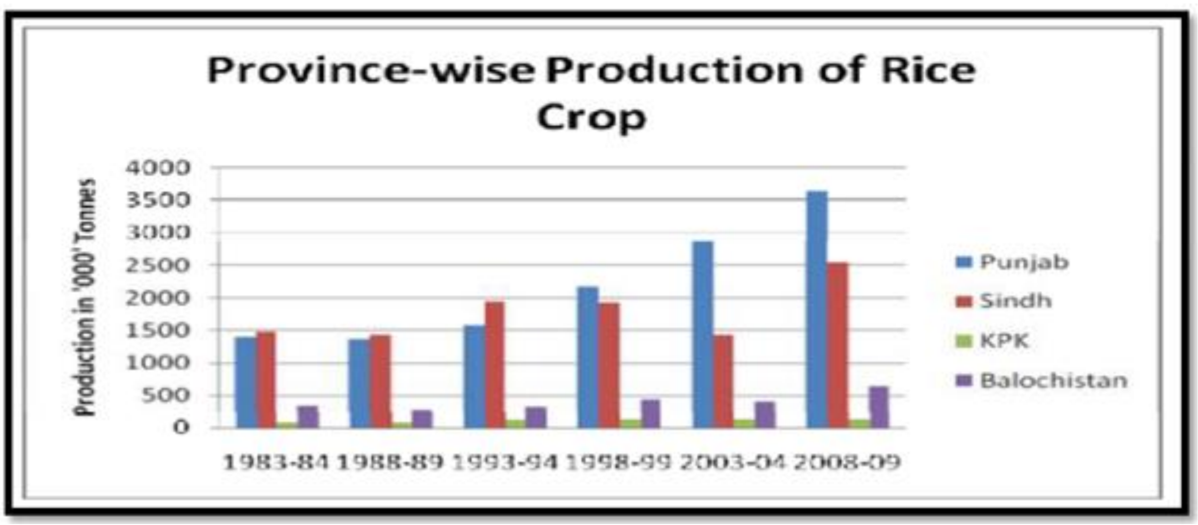


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 84: Province-wise Area Under Maize Crop

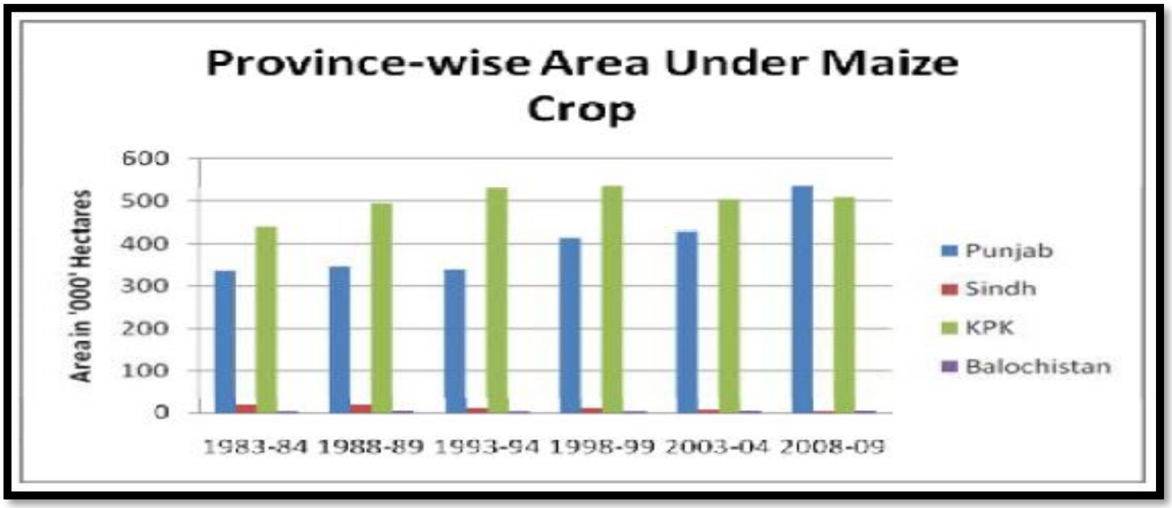


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 85: Province-wise Production of Maize Crop

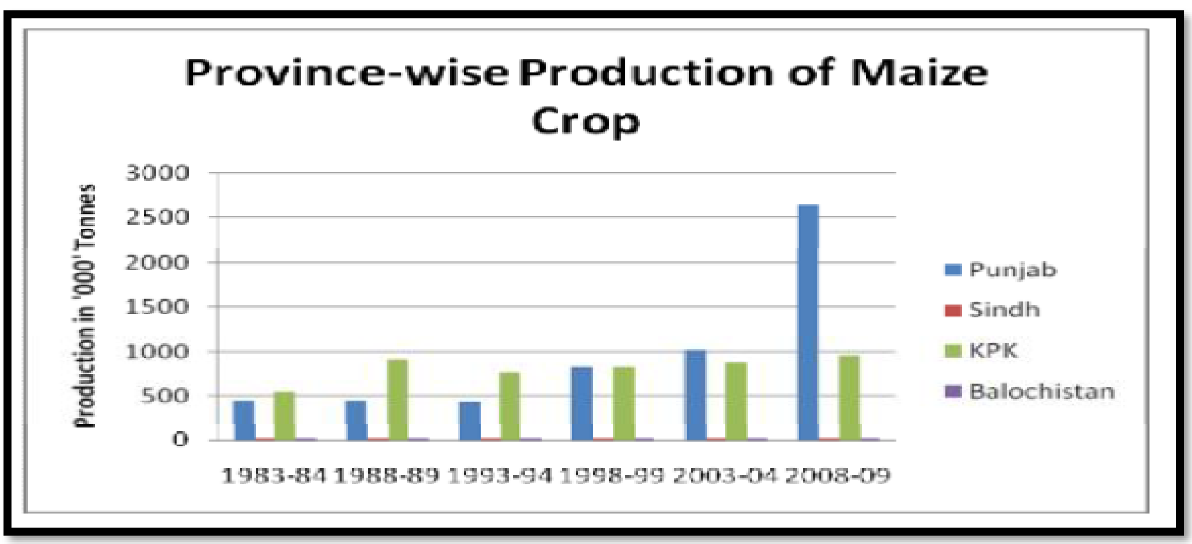


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 86: Province-wise Area Under Bajra Crop

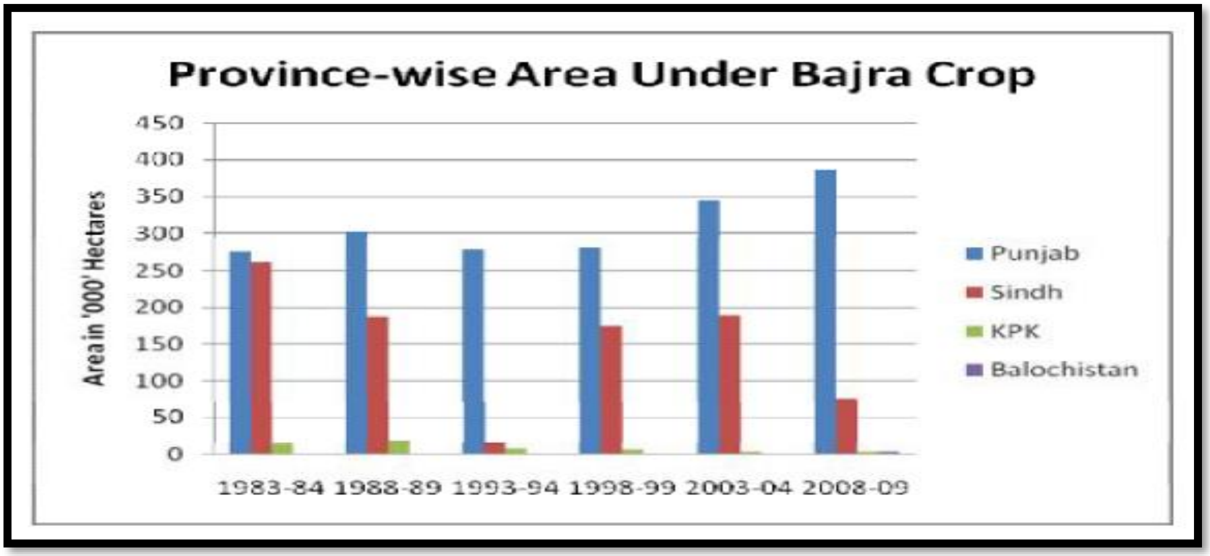


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 87: Province-wise Production of Bajra Crop

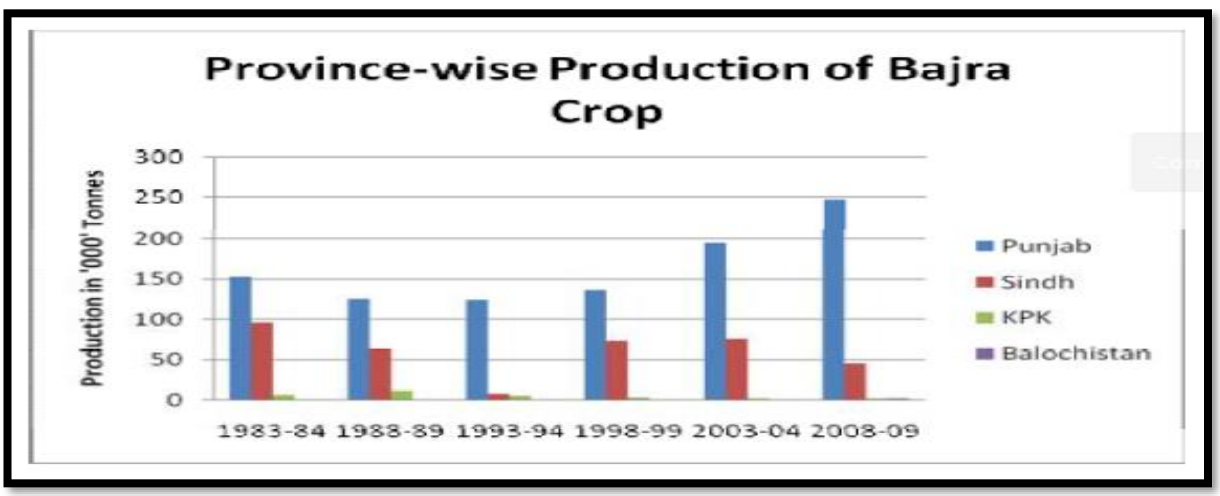


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 88: Province-wise Area Under Jowar Crop

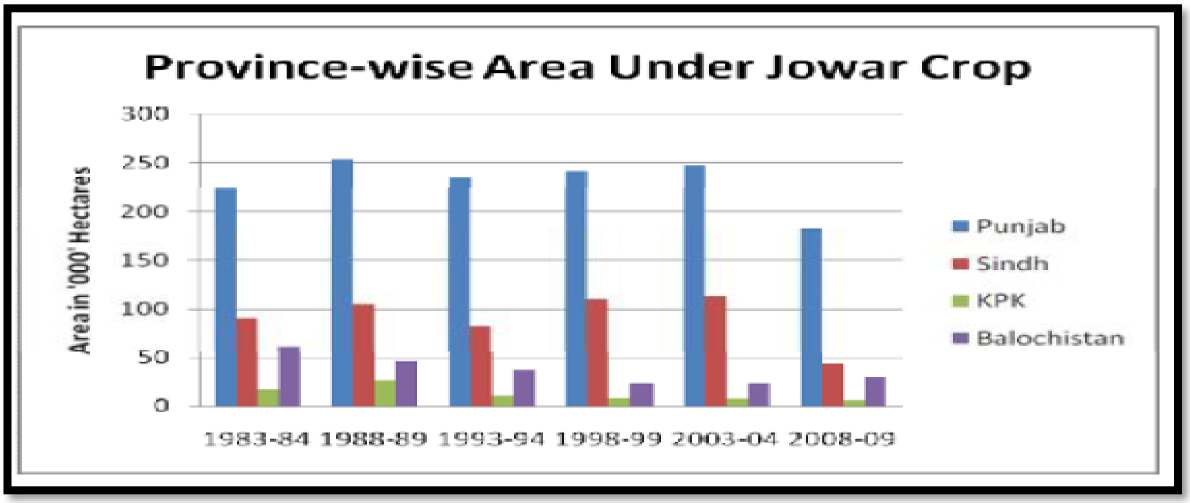


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 89: Province-wise Production of Jowar Crop

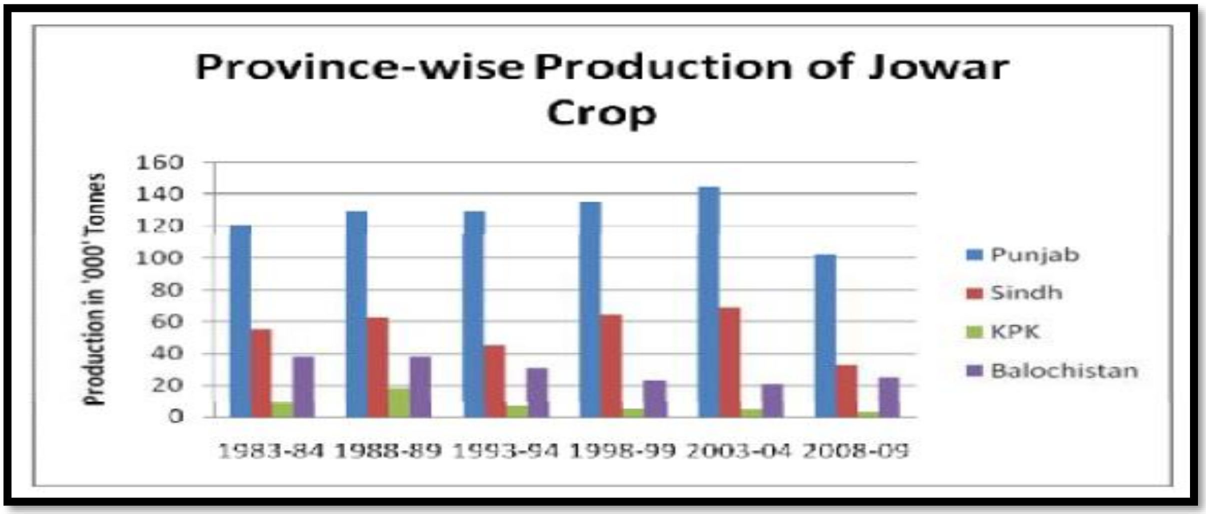


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 90: Province-wise Area Under Barley Crop

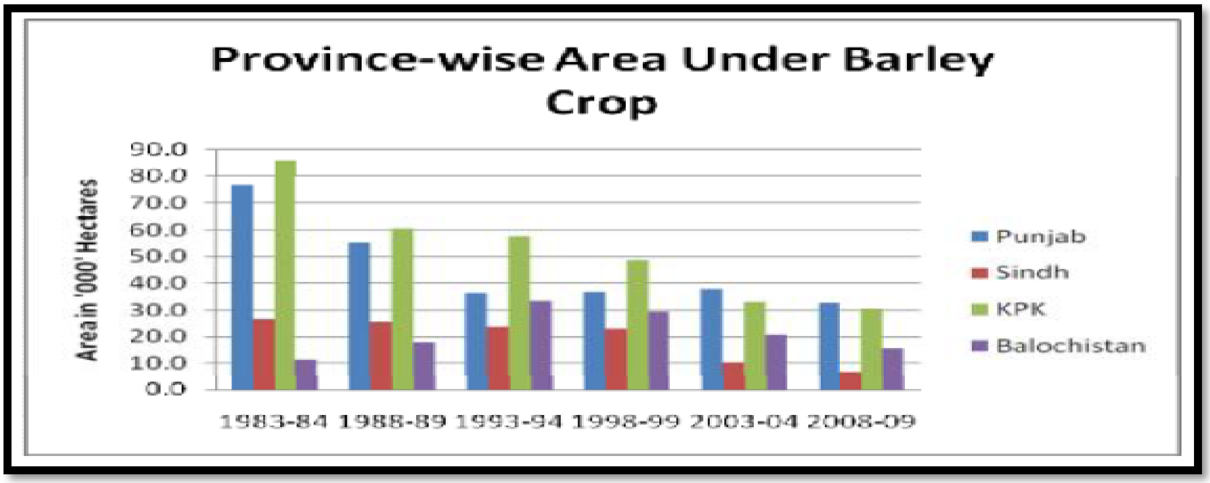


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 91: Province-wise Production of Barley Crop

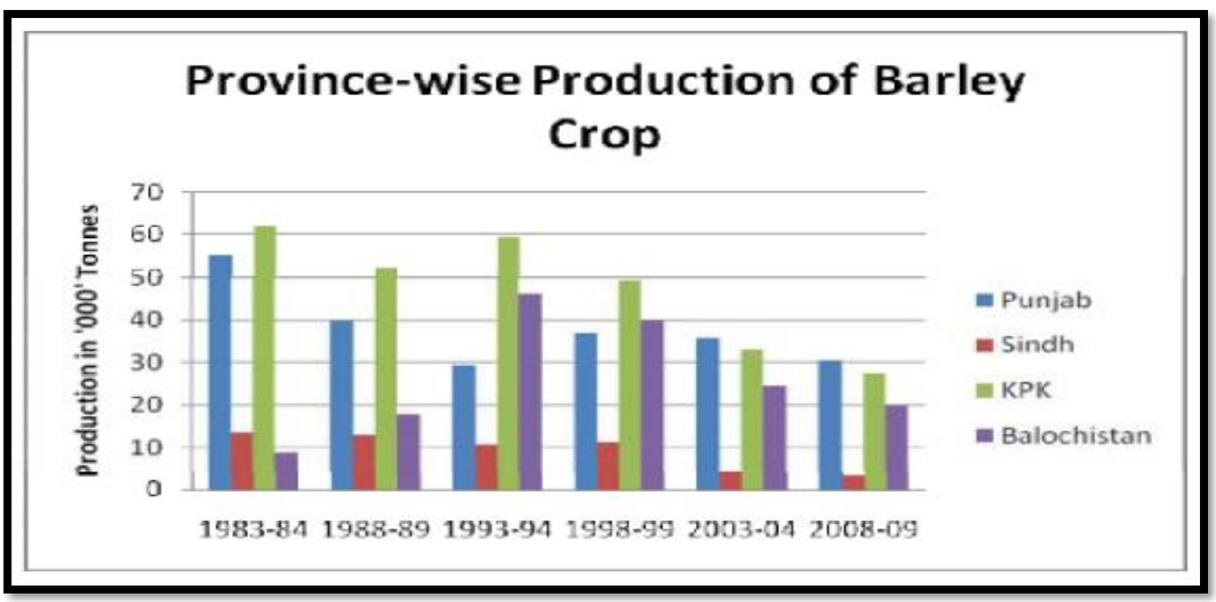


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 92: Province-wise Area Under Sugarcane Crop

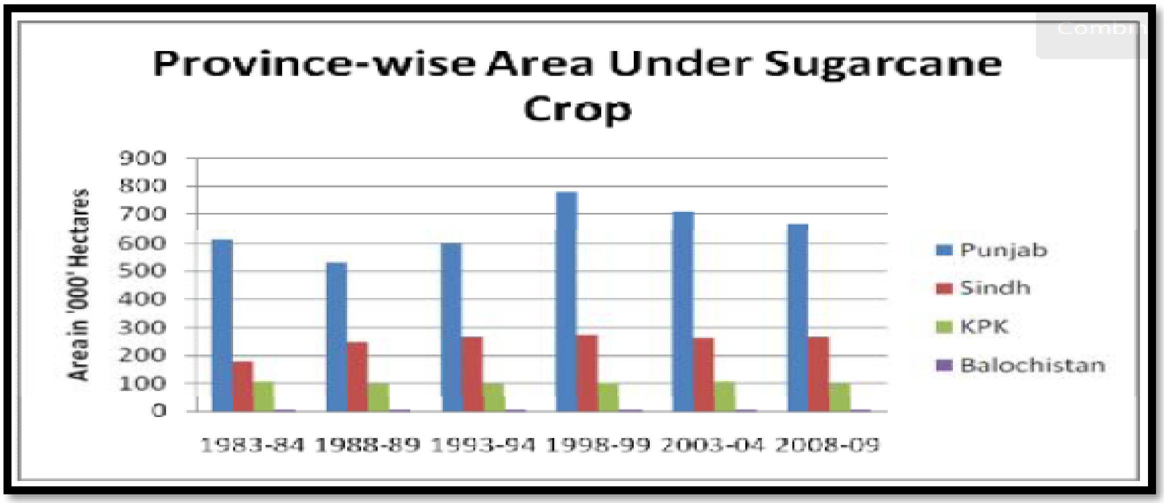


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 93: Province-wise Production of Sugarcane Crop

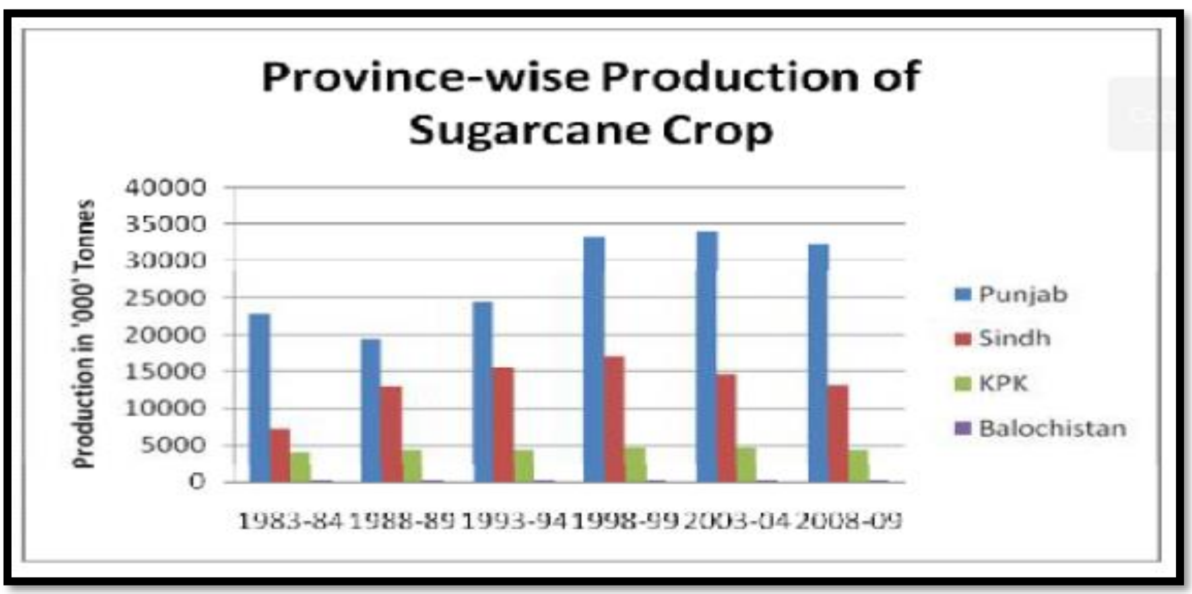


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 94: Province-wise Area Under Cotton Crop

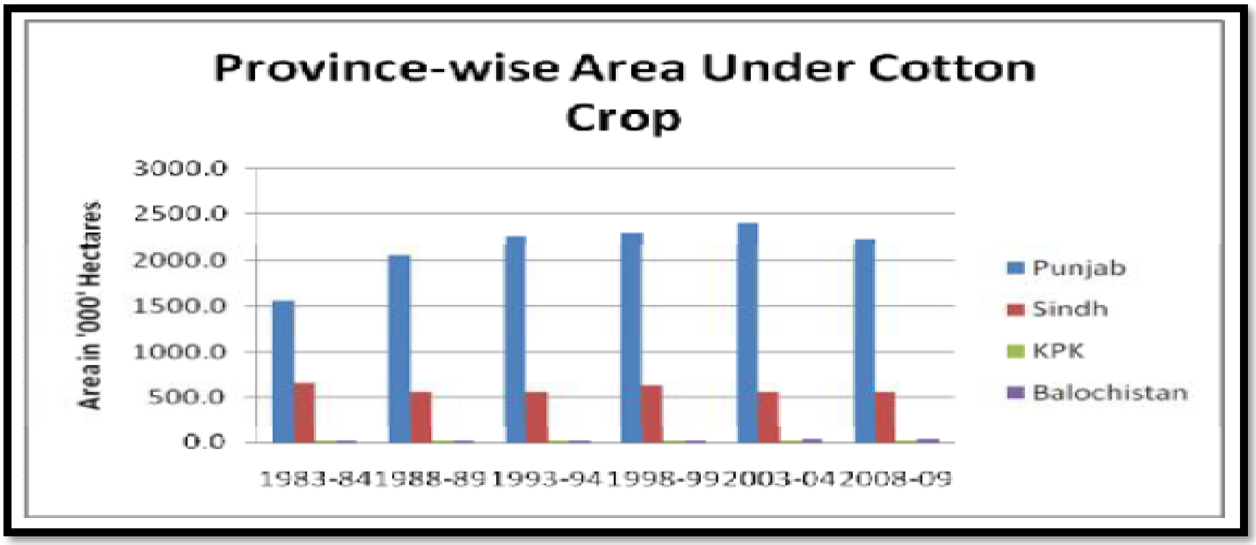


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 95: Province-wise Production of Cotton Crop

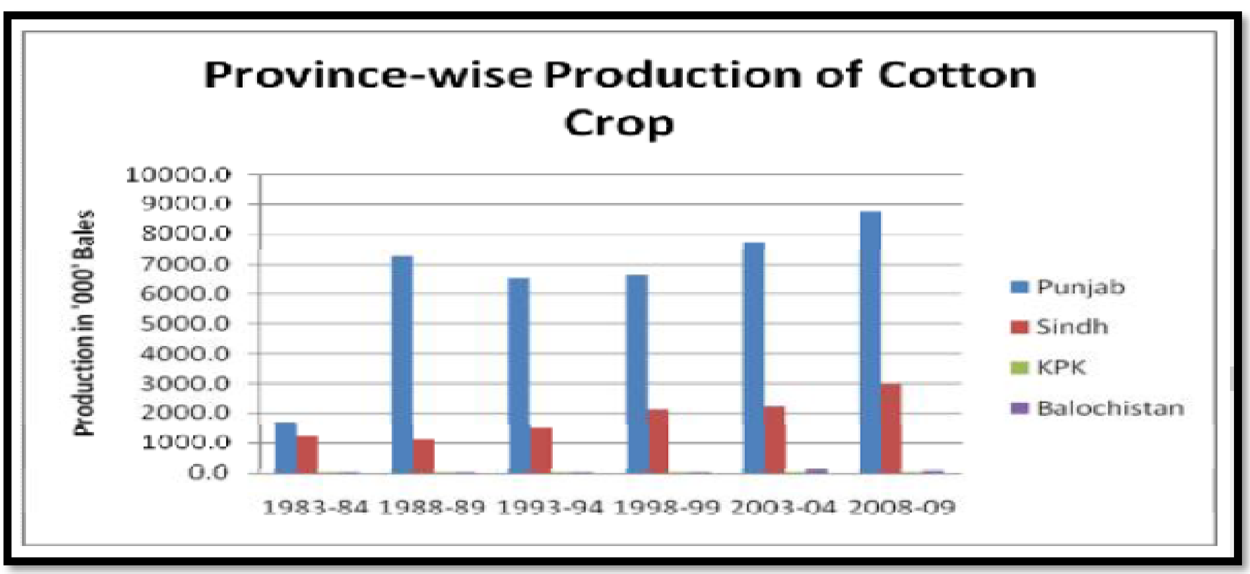


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 96: Province-wise Area Under Tobacco Crop

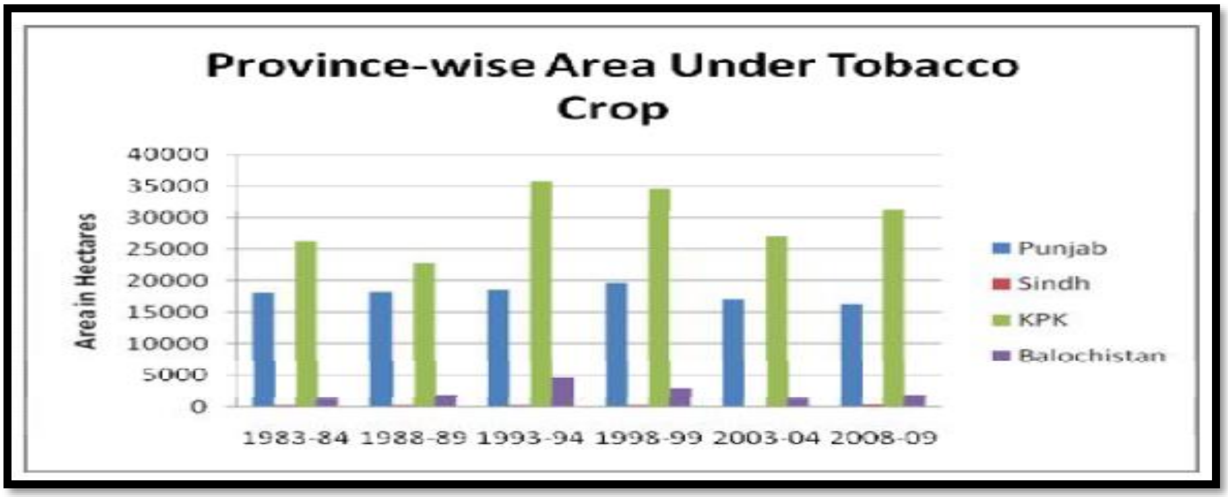


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

Figure 97: Province-wise Production of Tobacco Crop

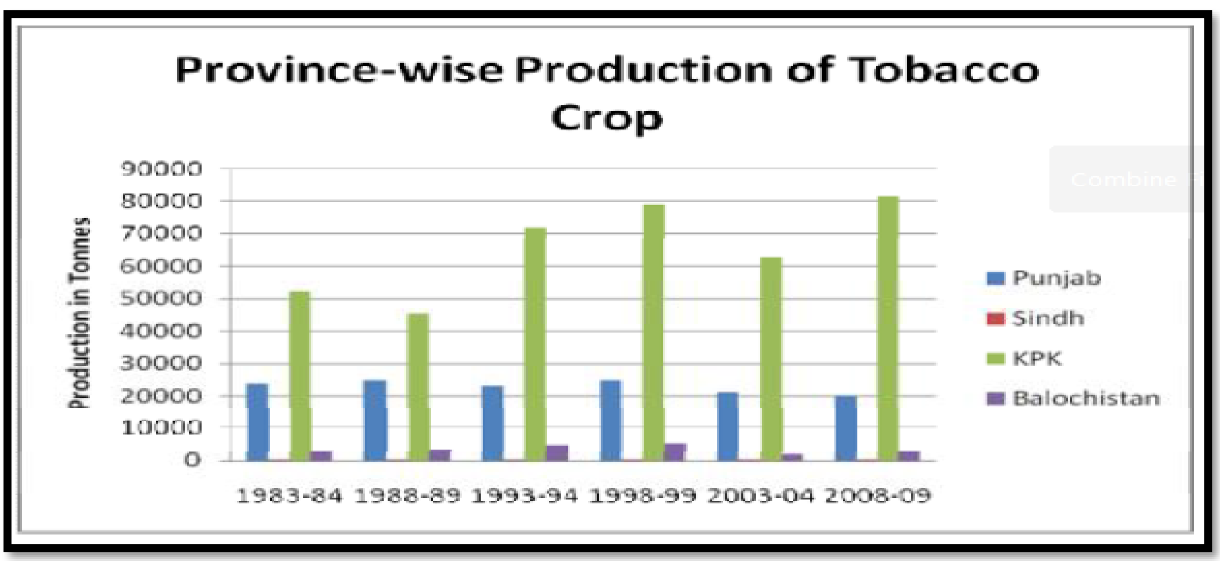


IMAGE SOURCE: Pakistan Federal Bureau of statistics (http://www.pbs.gov.pk)

After examining the figures on province-wise area and province-wise production, we can see some clear trends. All agricultural products except jowar, barley, and tobacco show an increase in production especially in the province of Punjab. Wheat, rice, maize, bajra, sugarcane and cotton, all show a significant and constant increase in the province of Punjab. Sindh shows an increase in crop production only in terms of rice and cotton. For all other crops the agricultural production of Sindh either remains constant (only wheat and bajra) or shows a decline (maize, jowar, barley, sugarcane) over the years. This reiterates and supports the finding that we had from the NDVI maps about the hotspots of low agricultural productivity in Sindh. The other provinces like Baluchistan and Khyber-Pakthunwala (KPK) either have insignificant to no production or shows a constant decline in crop production over the years. KPK shows an increase only for tobacco and has prominent maize production over the years.

After looking at the above facts about agricultural production, one cannot help but think how Pakistan's growing population and its food demands will be sustained with the help of increase in agricultural production only in the district of Punjab. In addition to this, while looking at the NDVI maps, Southern Punjab, especially the district of Bahawalpur, showed signs of dwindling agricultural production. The two staple crops rice and wheat show an increase only in Punjab and to a certain extent in Sindh. With increasing population and shortage of water, this dwindling agricultural production can cause serious problems with food security and availability. Bahawalpur has become an important site for terrorist recruitment by the LeT(Lashkar-e-Taiba) and other terrorist groups due to crop failure and increasing farmer distress.

POLITICAL RELATIONS, WATER SHARING AND THE IMPACT OF THE INDUS WATER TREATY

Research questions 3 and 4 help in answering how the water sharing conditions have been affected by the political relations between both countries and where the State of Kashmir fits into these political tensions. Question 4 helps us explore how the Indus Water Treaty has helped in guiding and ameliorating the political hostilities between both countries. Although a lot of researchers and academicians have constantly talked and published about the political tensions between both the countries (as discussed in the literature review), I explored an untouched and overlooked aspect of the political tensions between both the countries—the plight of the State of Kashmir. I have already discussed the history of formation of Kashmir and the reason behind the region being a source of political contention in the introduction.

The most ignored topic in the Indus water research is how the Kashmiris are being denied their own rights to access to Indus waters due to India's treaty with Pakistan and the dispossession of peasants from agricultural land for building dams on the Indus Rivers. Author Peer Ghulam Nabi Suhail (2018) mentions in his book,

> While IWT, hydro politics in India and Pakistan, and role of NHPC in exploiting water and land resources of Kashmir catches frequent newspaper headlines and have become subject of many academic studies in Kashmir and South Asia; however, dispossession and displacement of thousands of peasants in Kashmir due to land-grabs by the same corporation has not generated much debate in media or in academic studies. Even civil society and human rights groups have not raised the issue of displacement and dispossessions of peasantry due to these land-grabs (Suhail 2018, 16).

While conducting my key informant interviews in Kashmir regarding the current situation of the water, some interesting viewpoints/facts were discovered. The interviewees were clearly annoyed and oppose the way the "Indian Government" has been handling the water resources in Kashmir.

The attitude of the interviewees towards the Indus Water Treaty and the governments of India and Pakistan were a new discovery for me. I consider the information that I gathered about Kashmiri people through the key informant interviews as an important original contribution of my research. I think I was successful in finding the answers that I was looking for in research Questions 3 and 4.

> Kashmir is the source of water and Pakistan and India are the beneficiaries, but actual victims are living in this area. If you go to Bandipura or Lolab you will see the victims. Lolab is considered historically as one of the richest places in terms of water resources.

Now Lolab is facing water problems. We don't have any natural springs there. They have all dried up because of India using the Kishenganga dam and rest of the water being diverted. The farmers in that area don't have rice fields anymore. They grow corn. Farmers in this area are facing problems. India built the Baglihar dam in all the cultivated land that's not part of the project, so now we have food shortage, locals in 1947 used to produce enough food for Kashmir valley. Now most of our food comes from other states of India. And water has also inflicted pain upon people because NHPC, they came as colonizers and they are taking all the resources, they are producing electricity and that electricity goes to the northern grid, not to Jammu and Kashmir and if Jammu and Kashmir needs electricity then we have to go back to the north grid ask for it and pay for it, and we do not even get the share that was promised to us, even though that is illegal. I don't know the problems faced by Pakistanis, they have other resources, like Neelum, it goes to Muzzafarabad and then to Pakistan, they have built dams, the Jhelum and Neelum goes together and afterwards, they have built dams on that. But the population who should benefit get nothing out of that, so for me it is the people who should have been the beneficiaries have become the victims and people who should actually be paying for using water in Jammu and Kashmir are getting benefits. At some point we wanted to have Wular barrage, it was the biggest lake in Asia, and now it has shrunk to such an extent that if you go there you can actually walk over the lake. And we couldn't do it, because if we wanted to use it there was the Indus Water Treaty and our politicians who have been basically representatives of India in Kashmir because of the conflict. They can sign any document on behalf of India, we don't have any problems with that, but not on behalf of Kashmir. Why can't we use our natural resources? And why can't we benefit from our natural resources? (Interview with natural resource activist on 16th July 2018).

The condition in Lolab and Bandipura where the Baglihar and Kishenganga dams have been built has been particularly susceptible to the negative impacts of the dam building. Both Lolab and Bandipura are facing water problems. There are no natural springs left in these places, because of the extensive water diversion. There are no more rice fields left in these locations. The farmers in these areas are growing corn instead of rice, due to the water problems. The Baglihar dam used a lot of the agricultural land while being built. Because of this the locals face food shortages. Previously the farmers used to produce enough food for the Kashmir Valley. Now most of the food for the state of Kashmir comes from other states. In Bandipura, one by one, villages and forest lands are being destroyed.

> If we dry up, what are you going to use? There will be no water. What will you do with the dams on theses rivers? You have changed the entire ecology in Jammu and Kashmir. You have devastated forests. They are constructing another tunnel from Gurez to Bandipura, Gurez to Lolab. Tunnels are devastating. In Kashmir, wherever you go, if you go for trekking, you will see people living in thick forests. There have been people living in forests and mountain terrains and you built a tunnel in between, so what happens is all the water goes down there, seeps in, comes out of the tunnel. Now people who were using the natural springs, they don’t have water now, they have to migrate. There are hundreds of villages without water. All the chemicals used in the tunnel go into the water. How can we expect fish? Wherever the water goes it kills the fish. Aquatic life changes. There are no more fishes in Dal Lake. Wular which was a great source of our food, is nowhere. Baglihar you won’t see anything. Salal is another lake. Look at the agricultural areas. Surankot, how it has suffered. Look at how Punj has suffered, because the water goes via Surankot, Punj. Here it goes to Uri. There was hardly any agricultural area near Uri. There is another hydroelectric power at Uri 2. (Interview with a political activist on 21st July 2018.)

In Bandipura, there are villages located just above the NHPC project and water oozes out of the houses due to excessive building of tunnels. The electricity being produced by NHPC is going to the Northern Grid, which is in turn distributed to other states of India. According to the interviewees, Jammu and Kashmir does not get the share it was promised. A very alarming fact that I noticed during my field trip was that there used to be regular power cuts, sometimes from morning until evenings every single day.

"There is no power in winter almost for 2 days sometimes, media has corrupted, no one speaks the truth in front of the media" (Interview with locals in Srinagar on 17th July 2018).

> NHPC essentially, they have built dams all over whether its Uri, Baglihar, even in Kishtwar, there are so many all over. Electricity generated is taken to Northern Grid, we are not benefitting. Even the government of Jammu and Kashmir, recognized by India as their government, are not benefitting anything, not officially giving us any share. NHPC didn't give us as a royalty as a benefit, as a share in whatever they are taking from us. Its India as a country maybe, or the elites. Or the big corporations are benefitting, how are we benefiting? We have serious electricity crisis during winter. We have to buy electricity. So how are we benefitting. Another aspect is the colonial mindset. The hydroelectric power projects are in Jammu and Kashmir but most of the employees are from the rest of India and not from the state of Jammu and Kashmir. It's only the people who do menial jobs there, maybe 5 or 10% are from Jammu and Kashmir. The rest of the engineers, the highly skilled people, the semi-skilled people are hired from other states, they are not from Jammu and Kashmir. It's not that we don't have the engineers, the highly skilled and semi-skilled people. Because it's by choice. They don't want us to work here (Interview with a Kashmiri lawyer on 18th July 2018).

The interviewees were more concerned about the condition of the state of Kashmir, rather than what is happening regarding the India and Pakistan divide on the Indus Water Treaty and Pakistan's water shortage. The interviewees believed people should pay money for using the resources of Jammu and Kashmir as they are getting all the benefits. The Wular Lake which used to be one of the biggest lakes in Asia, has now shrunk to an extent that people can walk over the lake. The people and government of Kashmir often feel they do not have a say in the way the water resources in Kashmir can be used. For example, they could not do much to protect the Wular Lake by building the Wular Barrage as India already has an agreement with Pakistan about what dams to be constructed and where.

> The Amarnath Yatra, an annual Hindu pilgrimage, which used to have some 5000-people going for pilgrimage in the Upper Himalayas, now have about 200,000 people performing the pilgrimage annually. This causes immense destruction to the fragile Himalayan ecoregion of Jammu and Kashmir and environmentally deprecating. The pilgrims dumping waste and plastic materials on the glaciers lead to pollution of the rivers and other water bodies which originate in the glaciers There are no facilities for proper washrooms for so many people. Also, the heat generated from the choppers landing near the glaciers, while carrying pilgrims, leads to further melting of glaciers (Interview with a local lawyer and water rights activist on 17th July 2018).

The Government that came to power in Kashmir in 2002 under Mufti Mohammad Syeed entered with a poll promise to bring back the ownership of all the power projects to Kashmir, as these would bring energy security and economic revival in Kashmir. Mufti did write a letter to the then Prime Minister of India, Manmohan Singh on 7th October 2004 almost 17 months after coming to power, "…requesting him to transfer ownership and control of 690 megawatt (MW) Salal HEP to Jammu and Kashmir state" (Suhail 2018, 2). While the letter was acknowledged by the Prime Minister, no promise was made to transfer the ownership of the hydroelectric power stations to Kashmir. Mufti again came to power in 2014, but passed away in 2015, and since then even his political party did not talk about transfer of the power projects as they realized that they neither had the power or authority to do it (Suhail 2018).

Since 1947, while the Government of India continued to provide subsidies on water, food, electricity and other basic needs to the Kashmiri people as a strategic move to win over the Kashmiri people, the Indian Government also tried to fit in the Nehruvian model of development by building power projects and dams in the glacier fed rivers and produce cheap electricity (Suhail 2018). "However, contrary to the debate arising on the projects among the academic circles in India, in Kashmir, these HEPs did not become a matter of public discourse, nor did the impact of these HEPs on peasantry create any major resentment. The reasons being, (a) these projects being constructed in mountainous areas, where people's voices are not heard by the government authorities or media, and (b) these HEPs were projects as solving the electricity vows of the region" (Suhail 2018, 69). There have been open protests by the peasants against these constructions. Since the peasants are poor they do not have the money to actually contest their cases in the courts.

> Under the Indus Water Treaty, all the waters of Eastern rivers namely Sutluj, Beas, Ravi of the Indus basin, which flow through Himachal Pradesh and Punjab, have been made available for unrestricted use of India for utilization of their water for irrigation and power. The waters of three Western rivers, namely, Chenab, Jhelum and Indus, which flow through J and K, have been made available for unrestricted use of Pakistan. Under the Indus Water Treaty there is a restriction on the total storage capacity, which can be created on the river system of Jhelum, Chenab and Indus.
>
> Accordingly the State Government has been forced to consider the hydroelectric schemes, as "run of the river" type only. The debilitating fall out of the arrangement is that the installed capacity of the projects in J and K is reduced. If storage was permissible it could have been utilized to store the summer discharge which would have resulted in additional generation capacity particularly during winter months, when the demand for power is at its peak in the state. This has meant reduced power generation in the valley in the winter months due to low discharge of water. The generation goes down to 25 to 30 percent of the installed capacity during the winter months of October to March, resulting in recourse to high cost gas-based generation of a larger import of costly power from Central power station. (Excerpts from the letter of Mufti Mohammad Syed's letter to Manmohan Singh; Source: - Report of the Cabinet Sub Committee (CSC) of the Government of Jammu and Kashmir (2011:86-8) Suhail 2018, 4).

"While IWT did not serve the interests of the Kashmiri people has been established by the literature at the same time, violation of agreements and land and water grabs by India's Public Sector Undertakings (PSU), such as, National Hydroelectric Power Corporation (NHPC) is seen as the extension of resource exploitation in Kashmir" (Suhail 2018, 14).

“No doubt, in mainland India, NHPC is considered a corporation that has been generating electricity for energy hungry corporation in India and building ‘sacred’ infrastructure in Kashmir that strengthens India’s presence in Kashmir. However, in Kashmir valley, right from Salal HEP-I to KHEP, NHPC has been accused of exploiting the resources of Kashmir, violating the contracts, cheating, and bribing bureaucrats to get an unfair advantage” (Suhail 2018, 15). The State of Jammu and Kashmir gets only 12% of the revenue generated from the HEPs (Hydroelectric Projects), where 40% of the total electricity generated by the National Hydroelectric Power Corporation (NHPC) in India comes from Jammu and Kashmir. A large part of this 12% revenue goes in either enhancing its own electricity generating capacity or to purchase electricity during the winter months from the other northern states (Suhail 2018). Due to immense external pressure and the civil society in Jammu and Kashmir, the state government passed the Jammu and Kashmir Water Resources (Regulation and Management) Act, 2010, “…which allows the state to charge all the agencies which would generate the electricity for water usage” (Suhail 2018, 158).

The key informant interviews helped me not only in answering research questions 3 and 4, but also helped me in finding new information which is not usually researched or looked into due to political reasons and not shared much in academic circles. It helped in understanding how the water sharing agreement is affecting the people of Kashmir. The Indus Water Treaty and its provisions are not enough to sustain peace and economic development.

I think that there are a lot of issues which the general public are facing due to the provisions of the Indus Water Treaty, like displacement, unhealthy water conditions, loss of agricultural fields, drying up of lakes and other environmental repercussions. The Treaty does not address these problems. The Indus Water Treaty is a document created in 1950, which needs to be amended and updated to live up to the needs of 2019. Although easier said than done, there needs to be some serious research conducted to look into the social, political, economic and environmental repercussions of the Indus Water Treaty.

FUTURE WATER CONDITIONS

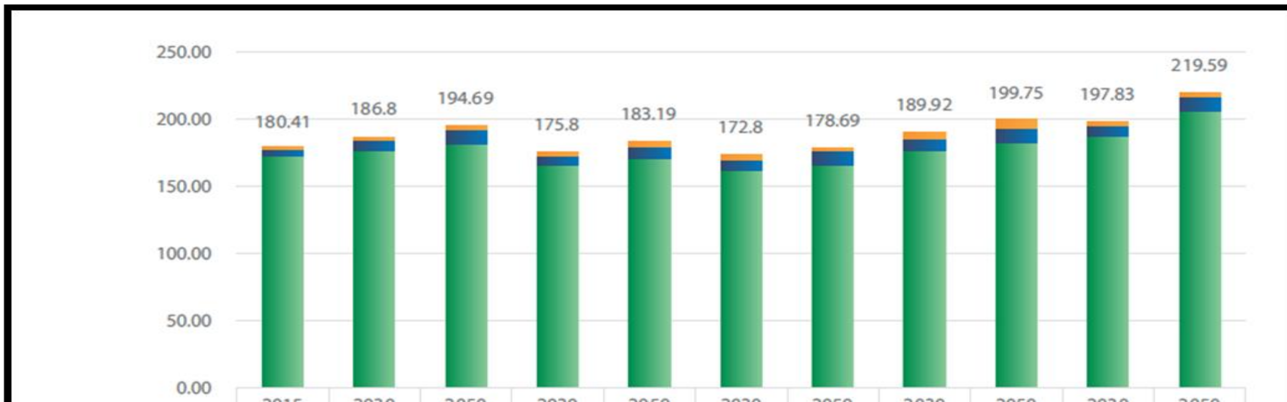
The aim of this section is to answer my research question number 5 about what the future water conditions look like for India and Pakistan, especially in the Indus basin, and what can be done to replace the heavy dependency on the Indus waters. The agricultural statistics and trends discussed in the previous section already show a decline in agricultural productivity in certain hotspot areas like Larkana, Sukkur, Sargodha, and Bahawalpur. Various reports on Pakistan's water study and many of my key informant interviewees revealed that, due to water mismanagement, climate change and growing population, Pakistan is at a greater water risk than many other countries in the world. Pakistan's dwindling water resources and the projected water scarcity is a well-researched topic in water literature. The impending problem of water scarcity was mentioned numerous times by my key informant interviewees. A closer look at the water and population statistics in the reports of the Census of Pakistan and United Nations confirms the water scarcity fear.

The surveys of the farmers in Pakistan revealed that, although production has increased since the time of partition, and there are irrigation techniques to draw more and more water as in groundwater and the canals, there is still a shortage of water. The problem of water shortage is not only related to the inflow of Indus waters, it also has to do with the excessive withdrawal of groundwater, which is leading to the water table moving down at a rapid rate. Using tubewells and digging them wherever water is needed for irrigation has become costlier. The farmers are of the opinion that educating people further about groundwater and proper water storage will help them. The farmers were also vocal about not having proper rains. A lot of water is wasted in the process of irrigating the agricultural fields or it is contaminated. Pipes and other equipment which are used by the farmers for irrigation should be made cheaper. Most of the farmers say that the Indus Rivers are flowing close by but not directly in their own locality. So, they rely more on groundwater. The farmers are of the opinion that if the water conservation techniques are not improved, the future generation will definitely suffer.

Pakistan's population has seen an upward rising trend since the birth of the country in 1947 (Table 2). However, the water availability for Pakistan's needs may not be enough for Pakistan's growing needs. A look into Pakistan's current and projected per capita water availability confirms this. "Pakistan, which has the world's sixth-largest population, is projected to add nearly 100 million people by 2050, causing great strains on its resources. Plus, ambitious plans for economic development could mean the country increases carbon emissions by 300 percent over the next 15 years, as more cars clog roads and demand for electricity expands, according to projections" (USA Today 2018, para 13). Pakistan is an agriculturally-based economy. As the population increases further, the farmers and the government will be under greater pressure to produce more food, with the help of the already dwindling water resources.

The figures provided on the next page (Figures 34 and 35) on future water demand scenarios in Pakistan clearly shows the water demands scenario up to 2050 in different sectors like industry, municipalities and agriculture. The figure clearly shows what would be the water conditions if the water demands and availability are affected by the climate change scenario; high increase in water demand and moderate increase in water demand.

Figure 98: Water Demand Scenarios in Pakistan



	2015	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
		Business as usual scenario		moderate demand management scenario		Strong demand management scenario		Business as usual scenario with exceeded extrapolation		Climate change scenario	
Industry	2.30	2.65	2.73	2.65	2.73	2.65	2.73	4.70	5.80	2.65	2.73
Municipalities	5.11	7.15	9.96	7.15	9.96	7.15	9.96	8.22	11.45	7.58	10.66
Agriculture	173.00	177.00	182.00	166.00	170.50	163.00	166.000	177.00	182.50	187.60	206.20
Total	180.41	186.8	194.69	175.8	183.19	172.8	178.69	189.92	199.75	197.83	219.59

Agriculture Municipalities Industry

IMAGE SOURCE: Water Security in Pakistan: Issues and Challenges, pg. 19

One of the key reasons for water shortage in the future will be due to climate change. The constant melting of glaciers in the Himalayan mountains has led to flooding in Pakistan. Floods have occurred in 1956,1957, 1973, 1976,1988, 1992, 2010, 2011 and 2012. Pakistan also had severe droughts in the period of 1998 to 2004. The per capita availability of water has reduced from 5140 m^3 in 1950 to about 1000 m^3 now (Hussain and Mumtaz 2014). It is speedily proceeding towards water scarcity. Figures 34 and 35, compare the increase in population and water availability in the future. The official numbers show a drastic decline in the numbers, which means that if Pakistan is not careful about how she uses her water, it will lead to other problems of food security, problems of accessibility to water ad also availability of clean water.

Figure 99: Current and Projected Per Capita Water Availability of Pakistan

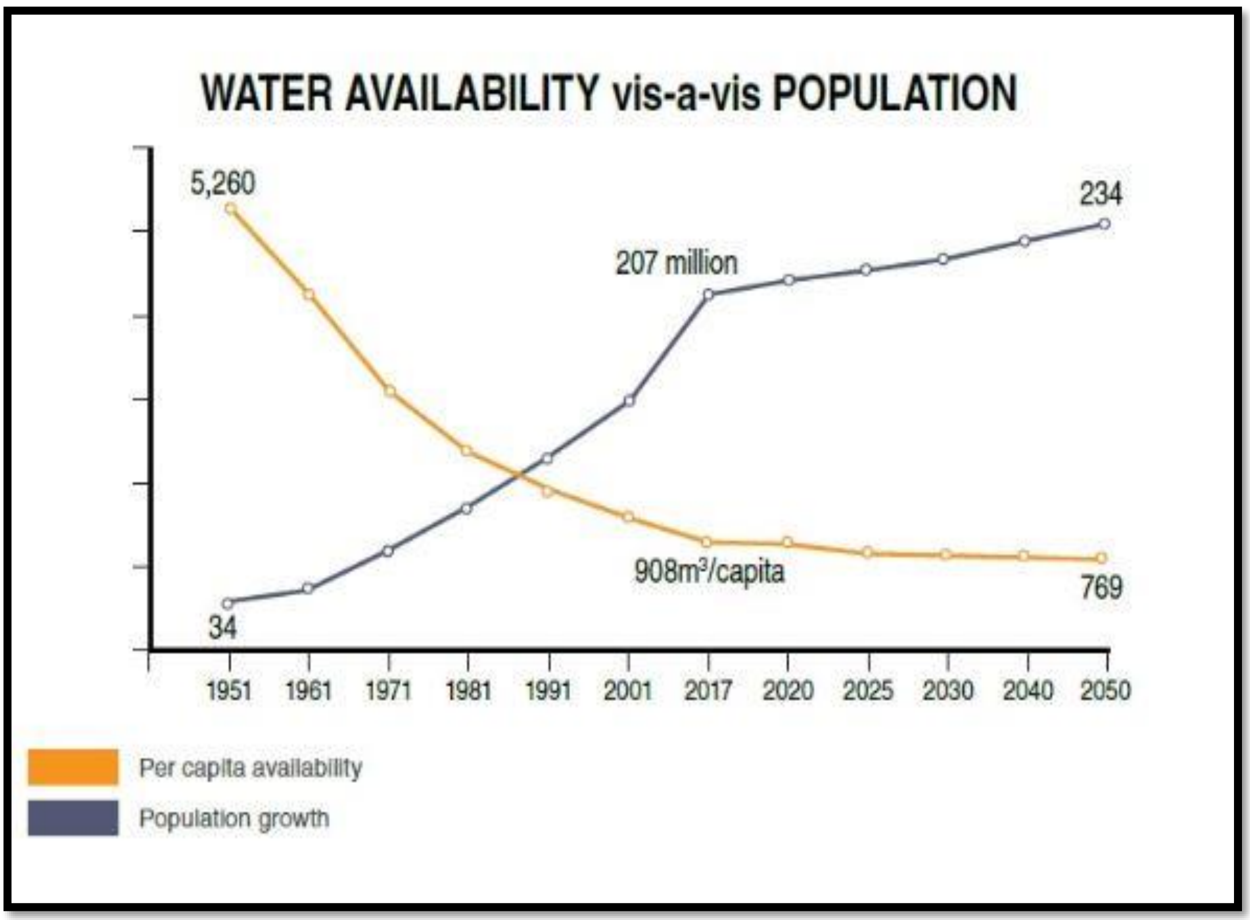


IMAGE SOURCE: Dawn, (1998), A Rational Approach to Indus Water Distribution. Dawn Economic and Business

Table 2: Projected Per Capita Water Availability in Pakistan

Per Capita Water Availability		
Year	Population (Million)	Per Capita Availability (m^3)
1951	34	5300
1961	46	3950
1971	65	2700
1981	84	2100
1991	115	1600
2000	148	1200
2013	207	850
2025	221	659

IMAGE SOURCE: Draft State of Environment Report 2005

All the research questions and the findings suggest a future lack of water resources and water scarcity affecting agriculture and water sources for domestic needs. I have faced several limitations in terms of international field-work. This research has the potential to open new doors and new research directions. Further research can be done on how the agriculture of Jammu and Kashmir has been affected. More farmers who work on the Indus Basin can be interviewed for a better understanding of what people face due to the current water sharing agreement.

CHAPTER V

CONCLUSIONS

The Indus River System consists of six rivers, out of which the Indus is the main river. The other five rivers in the system are the Ravi, Beas, Sutlej, Jhelum and Chenab. Disputes over the shared water resources of the Indus has been a common theme for conflict between India and Pakistan since the time of partition of India to India and Pakistan in 1947. The hasty drawing of the political boundary between India and Pakistan in 1947 led to the boundary cutting across the rivers and dividing the river into two halves, with the upstream part of the rivers in India, thus making it the upper riparian and the lower part of the rivers in Pakistan, thus making it the lower riparian country. The Indus Water Treaty was signed between India and Pakistan in 1950, brokered by the World Bank in order to have a permanent solution to the water dispute. The Indus Water Treaty is one of the most successful treaties in the world and remains intact in the face of wars and numerous terrorist attacks between the countries. Even with a successful treaty, there have still been issues relating to water sharing between India and Pakistan.

My research aims to address the repercussions of these water sharing issues on both India and Pakistan. The five research questions that I have used are geared towards understanding:

1) the past and present of the water sharing conditions between India and Pakistan and whether they have increased or decreased over time

2) how has the change in water conditions affected the economy of both the countries, specifically the agriculture of Pakistan

3) how has the water sharing agreement affected the political relations between India and Pakistan and what are the effects of this agreement on the State of Kashmir

4) how far has the Indus Water Treaty helped in guiding and ameliorating the water related hostilities between the two countries and

5) what do the future water conditions look like for India and Pakistan.

To address the research questions, I have used a mixed method approach involving key informant interviews, farmer surveys, archival research and GIS NDVI data. This research is important, unique, and an original contribution for two reasons; the broad study area involved, and the techniques and methods used. Previous studies have mostly focused on the Indian side of the Indus River system, or the Pakistani side. Most scholars take the side of either India or Pakistan based on their nationality. Some researchers have narrowed down their focus to particular agricultural villages irrigated by the Indus looking at how this area's agriculture has been affected by the water sharing statistics. Also, other researchers often concentrated on a single river of the Indus System and how it is used. I aimed at working on the entire drainage area, starting from the source of the Indus and its tributaries to the Indus Valley in Pakistan (See Figure 2). My broad study area allowed me to do a comparative analysis of the repercussions and perceptions of the water conditions of the two countries and this allowed me to look at both the Indian and Pakistani sides of the story simultaneously. This simultaneous observation of the two countries is one of the unique contributions of my research.

I experienced several limitations in terms of collecting my interviews and surveys. While doing this research I aimed to collect and create a composite table with river water inflow and outflow of both India and Pakistan. However, due to the classified nature of the data, it was not available on any governmental website or office. Some government websites like WAPDA (Water and Power Development Authority of Pakistan) did have records of the water stored and released by some dams. However, the data was only for a couple of years and not as extensive as I wanted. If I would have had the governmental permission, I would have liked to go and complete the farmer surveys myself and have a larger sample size. Although this is beyond the scope of this research, I would like to conduct more research on the disappearing agricultural fields and displacement of Kashmiri people due to the land being occupied by the government for building dams. This issue was brought up repeatedly by the interviewees in the key informant interviews.

The Indus water problem needs more research and policy implementation than the ones currently existing. The research questions and the research design helped me to find the answers that I was looking for. While looking at the first and second research questions, which deal with the past and present water sharing conditions and its effect on the agriculture of Pakistan, I used NDVI as the proxy indicator of water supplied by the Indus, considering that the most important source of water for the crops is the water of the Indus and its tributaries. “NDVI is often used around the world to monitor drought, forecast agricultural production, assist in forecasting fire zones and desert offensive maps. NDVI is preferable for global vegetation monitoring since it helps to compensate for changes in lighting conditions, surface slope, exposure, and other external factors” (eos.com 2019, para 1). “According to this formula, the density of vegetation (NDVI) at a certain point of the image is equal to the difference in the intensities of reflected light in the red and infrared range divided by the sum of these intensities” (eos.com 2019, para 2). The NDVI value may range between -1.0 to 1.0, where values close to zero indicate bare soil and large positive values indicate forests and dense vegetation in general (eos.com 2019). I also collected temperature and precipitation data to show how areas of low precipitation did not indicate low agricultural productivity, at least in the Punjab and Sindh, thus removing the natural precipitation as a factor in the vegetation index result. The NDVI maps during the two cropping seasons *Kharif* (monsoon/autumn) and *Rabi* (winter crops) show that there are significant areas where the agricultural land use has declined even in the Indus Basin. This indicates that either the volume of water in the Indus Rivers is declining or over used. I have also used some statistical data from Pakistan’s Federal Bureau of Statistics showing agricultural productivity and area covered by the crops since the 1980s. The statistics showed that there has been some decline in agricultural productivity, although cropping area might not have undergone much change.

In research questions three and four, which deal with how the Indus Water treaty has guided resolution to the water related hostilities between the two countries and the condition of the State of Kashmir, I had meaningful and deep insights from the key informant interviews and the archival research. The issues that the people of Kashmir have faced due to this water sharing agreement and how their problems have been overlooked is one of the most interesting discoveries of this research. Due to the waters of the Indus and its tributaries being diverted to Pakistan, the Kashmiri people have complaints that they do not get to use the water flowing through their own land. Also, the environmental and social repercussions of the construction of hydroelectric dams are huge and leads to displacement of large numbers of poor people from their own houses. Most of the lands where crops used to be grown have either been occupied by the government for hydroelectric power plant construction or the water that was once used for crop production has been diverted or significantly declined.

In my fifth and final question I tried to analyze what the future water conditions hold for Pakistan. For this research question, I have surveyed the farmers involved in farming in the Indus Basin to understand the water issues they experience in their agricultural fields and what the future water conditions might look like. I have also used statistics from Pakistan's Federal Bureau of Statistics. The farmers commented that they have been facing problems not only related to Indus waters but also excessive use and withdrawal of underground water. They were also vocal about climate change, and not having enough rain.

The Indus water problem needs more research and policy implementation than the ones currently existing. On a surface level, while looking at the agricultural data and trends, it might look like there is not much of a problem. The agricultural output pattern seems to be steady and constantly rising in some cases. However, as we dig deeper into the problem and try to look at other facets of this problem, like population increase, climate change, the amount of water needed for other purposes, it seems that we are anticipating a worse problem in terms of water and food security in the future of Pakistan and also Kashmir. Proper policy and implementation are needed in terms of water storage, excessive irrigation and salinization problems in the agricultural fields. For a river basin that is considered the largest irrigation network in the world, more research and study, better policies and constant update on new technology and their application is needed. The farmers farming in this river basin need to be better informed and educated about new technology and water saving techniques. This will only happen when the government of both countries will stop using the Indus problem as their political agenda to either strengthen their political parties' stand in the upcoming elections and to come to power, or just to show off which of the two countries has more power in global politics.

Both India and Pakistan need to be more cooperative in the future in terms of water research and problems of population and food security. The urgent need is not to decide on who owns Kashmir or the Indus waters; it is to work with the existing resources and their division and find the best possible way to achieve a sustainable livelihood for all people dependent on the water, in terms of food security, clean drinking water and also electricity. Due to the hostile political conditions between the two countries, researchers and academics either find it unsafe to research further and dig into the topic or look past the usual blame game between both the countries. For a better understanding of the problems and to face the uncertain future of water resources in this area, researchers from both countries need to join together and work on better policies to fight the challenges of climate change, water security and food security. More research can be conducted on using some of the theories of water management like Integrated Water Management, Adaptive Water Management, Game Theory and even proper Rain Water Management.

The governments of both countries should also work on protecting the fragile Himalayan environment which serves as the source of the Indus Rivers and sustain the life of millions of people living in the river basin. The Indus Water Treaty and how the Indus water is handled between India and Pakistan is already a successful example to follow for other transboundary river disputes in the world, in spite of the wars between the two countries. If India and Pakistan could collaborate and cooperate further on issues that impact climate change and the Indus waters and food security, then it will help millions of people in the Indus River Basin. There is a huge scope of research that can still be carried on in this area that will benefit many other countries and their people facing such transboundary water issues.

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APPENDICES

APPENDIX 1
Farmer Survey Questions

1) Are you or your ancestors originally from India or Pakistan?

2) How long have your ancestors stayed in India/Pakistan?

3) Did any of your ancestors live in Punjab before partition?

4) How long has your family been involved in cultivation?

5) What crops do you cultivate?

6) Have you always been involved with this crop? If no what else have you cultivated and for how long?

7) Has the crop production increased over time from 1960 onwards?
   Yes/No
   Can you give a reference by how much it has increased or decreased?
8) Are there any water related problems you face in your cultivation?
   Yes/No
   If yes, what problems do you face?
9) Do you think the water is being managed properly?

   Yes/No
   If no, what should be done to better manage water?
10) What steps have the locals in this place undertaken for water conservation?

11) Do you think the present water usage can affect the future availability?

    Yes/No
12) What steps or measures do you think can be implemented to improve the storage and management of water?

13) Are there any other water related issues you want to talk about?

APPENDIX 2

Key Informant Interviews

1) What is your current occupational description?

2) Are you in academics or a government job?

3) How long have you been involved with the Indus water sharing problem?

4) How do you think the water sharing agreement affected the political relations between India and Pakistan?

5) Is there any water related problem you think the farmers face in their cultivation?

    Yes/No

    If yes, what problems do you think they face?

6) Do you think the water is being managed properly?

    Yes/No

    If no, what should be done to better manage water?

7) What steps have the locals in this place undertaken for water conservation?

8) Do you think the present water usage can affect the future availability?

    Yes/No

9) What steps or measures do you think can be implemented to improve the storage and management of water?

10) Is there any other water related issues you want to talk about?

APPENDIX 3

Mean Precipitation During *Kharif* Season Data

		Mean Precipitation during Kharif Season															
YEAR	NAME	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
PROVINCE	Azad Kashmir	389.15	300.517	439.95	509.1	322.367	442.8167	375.1333	588.733	482.733	392.82	313.73	406.52	440.05	523.17	614.45	515.1
PROVINCE	Balochistan	40.021	49.9726	90.543	45.298	52.7411	100.1073	21.0871	96.9363	75.7185	62.922	16.299	71.377	23.788	163.22	70.722	36.2661
	Kalat	32.554	38.058	115.75	45.21	58.848	113.714	12.8	115.672	71.472	64.794	1.008	88.204	8.596	159.11	67.244	21.992
	Makran	5.265	11.95	57.715	15.96	11.25	49.97	4.395	48.79	10.97	12.79	0.16	16.24	0.735	77.825	53.44	2.77
	Nasirabad	68.6667	63.9167	93.117	39.767	113.967	166.7333	25.18333	131.617	146.433	66.767	10.383	94.033	27.383	295	77.817	47.3
	Quetta	10.5955	26.6591	26.686	3.1227	8.57273	29.95909	8.177273	32.0273	19.5364	18.559	1.5909	24.095	5.0591	42.382	22.482	7.01364
	Sibi	86.6125	85.575	104.54	65.488	113.863	174.2875	42.0625	133.6	162.713	94.038	31.738	97.438	56.513	332.03	105.14	74.4125
Districts	Zhob	105.089	133.339	127.96	122.56	88.2889	148.5778	67.74445	149.867	165.889	152.53	89.794	124.55	98.75	298.24	140.88	128.256
PROVINCE	F.A.T.A.	222.308	192.133	289.99	315.85	154.383	238.4333	172.4667	228.425	373.625	319.63	194.86	254.98	219.91	403.36	336.48	291.292
PROVINCE	N.W.F.P Khyber Pakhtunwala	259.196	183.914	305.92	307.61	185.254	308.3679	277.3607	274.211	311.846	244.74	205.39	254.1	255.46	375.05	368.47	306.604
	Bannu	207.6	181.9	284	249.7	132	184.1	88.3	183	310.7	307.8	181.2	199.7	181.2	340.8	301.3	227.9
	Dera Ismail Khan	192.825	147.125	248.9	194.95	106.975	146.6	63.675	157.85	237.65	263.88	167.2	149.2	161.05	309.4	254	187.9
	Hazara	356.24	234.04	370.72	425.74	260.08	434.46	402.92	447.5	419.18	281.36	271.02	345.44	380.68	482.58	517.88	431.48
	Kohat	242.6	216.45	335.55	339.25	161.25	241.05	139	227.65	382.45	352.85	202.1	263.85	228.05	427.2	373.35	299.8
	Malakand	212.458	142.992	220.67	203.88	151.908	287.5167	321.6667	208.042	225.567	150.48	168.23	204.76	202.88	260.04	274.38	246.008
	Mardan	457.05	317.85	616.4	703.8	374.4	556.55	412.55	555.1	550.55	436.45	349.2	490.4	484.5	747.95	725.1	577.85
Districts	Peshawar	258.2	189.8	424.1	446.8	209.1	326	238.9	266.7	372.6	313.5	198.8	302.1	271.6	495.4	436.8	360.7
PROVINCE	Northern Areas/Gilgit Baltist:	107.285	98.9185	86.537	96.022	74.3815	122.1556	167.2667	148.248	117.548	74.444	64.285	84.937	115.44	113.54	142.21	148.356
PROVINCE	Punjab	273.516	216.158	343.08	325.3	243.159	286.4889	148.7728	318.179	301.231	349.64	218.69	261.01	246.94	387.2	402.97	314.53
	Bahawalpur	148.356	150.525	199.46	126.39	133.781	161.4188	71.86875	156.588	173.263	174.16	84.106	148.24	136.39	237.06	202.58	166.688
	Dera Ghazi Khan	134.713	95.3533	165.2	125.93	127.28	155.34	65.19334	148.233	174.607	173.27	98.313	108.95	135.4	281.67	192.81	136.467
	Faisalabad	266.288	186.8	326.88	285.41	227.525	260.2	130.725	282.1	272.7	349.63	213.1	223.18	242.59	322.5	393.11	283.838
	Gujranwala	527.513	410.138	592.3	732.98	525.913	568.05	309.2625	759.838	562.025	725.69	477.86	560.33	452.55	629.85	799.55	676.625
	Lahore	410.783	307.933	430.92	499.83	423.217	421.6833	214.9333	541.4	416.767	559.3	332.75	395.75	308.58	424.62	576.2	495.883
	Multan	184.962	145.75	223.26	171.4	165.475	198.95	102.6	201.925	203.15	235.7	132.46	155.38	191.48	213.28	278.55	204.7
	Rawalpindi	468.65	376.68	660.17	685.46	379.86	506.41	314.31	538.88	531.37	552.67	401.56	494.35	445.57	743.27	725.48	564.77
Districts	Sargodha	277.91	211.42	379.37	306.66	195.7	248.1	114.94	245.55	289.11	356.5	229.43	230.67	238.86	403.96	402.54	281.86
PROVINCE	Sind	126.158	72.178	207.77	170.29	129.296	134.22	12.2	221.772	183.09	194.03	14.02	227.25	65.196	366.56	112.73	86.948
	Hyderabad	111.953	67.3529	228.09	180.07	114.476	137.7706	6.805882	240.982	173.518	173.39	7	242.52	38.247	373.4	111.98	54.8176
	Karachi	84.3	69	206.4	176	95.3	106.4	3	222.9	170.6	111.9	1.6	220.9	19.9	358.3	121.2	29.7
	Larkana	90.1167	34.6	93.783	64.483	130.183	134.8333	12.71667	115.083	156.5	80.867	7.0167	102.12	34.55	326.9	78.617	53.0167
	Mirpur Khas	190.864	115.871	288.89	258.74	159.657	141.9571	20.61429	302.521	228.586	330.67	31.721	327.89	127.79	416.27	147.99	163.936
Districts	Sukkur	92.3	47.0917	141.45	105.66	117.258	122.175	10.53333	153.6	157.908	127.3	7.85	151.31	49.45	319.38	88.992	64.3833

Mean Precipitation During *Kharif* Season Data (continued)

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
600.333	377.57	332.02	428.85	443.1167	393.48	477	379.93	298.03	691.78	409.2	465.08	265.6	688.8	433.23	324.08	532.08	447.23	598.57	393.6
113.494	32.836	42.994	25.3734	36.49677	25.651	99.65565	18.974	25.509	64.053	61.796	60.468	31.904	76.3226	48.701	29.719	52.765	15.977	48.676	35.739
100.6	22.996	32.508	16.564	36.8	19.786	106.908	4.978	9.874	68.266	62.974	51.958	36.136	58.08	52.64	15.358	50.416	4.588	21.172	28.776
35.085	3.19	5.745	1.995	15.13	19.24	34.61	0.455	2.2	12.785	14.37	31.595	6.5	4.185	11.885	2.275	42.585	0.15	1.06	7.865
194.867	38.233	91.4	36.4333	36.36667	11.267	180.9	16.5	24.833	90.267	84.367	74.95	20.683	129.1	84.433	24.983	56	15.217	67.783	37.183
41.7182	10.932	9.2364	3.48182	4.895455	2.7955	27.94091	1.6955	2.6318	17.082	10.55	10.714	4.1727	11.3864	12.523	2.5455	9.2455	3.7636	6.6182	6.8773
227.063	56.35	110.66	49.3625	57.5625	26.638	192	41.55	52.238	107.38	115.14	97.588	35.963	183.7	94.425	54.725	79.675	33.225	119.92	64.425
246.556	107.63	108.56	88.2278	88.7	81.356	171.3111	90.339	111.14	138.73	142.62	155.67	84.206	221.2	90.65	123.78	110.75	72.717	191.35	108.09
296.35	274.52	184.7	198.758	267.525	193.78	321.6583	265.46	235.08	308.95	283.79	428.34	224.98	514.35	290.19	277.08	363.85	232.53	431.51	276.64
292.736	264.93	204.18	268.4	276.6964	222.26	320.5071	255.71	205.07	335.56	277.28	370.02	196.6	544.832	272.44	229.27	340.28	230.86	407.19	255.37
239.6	221.7	163.2	188.4	229.3	147.1	275.9	251	256.4	215	246.1	381.4	217.1	450.4	249.6	281	272.7	185.7	379.6	295.1
209	173.23	140.38	179.6	192.875	117.85	221.825	210.73	251.18	151.98	215.28	306.68	184.33	398.6	178.68	250.95	183.18	129.38	312.43	259.63
437.34	342.52	274	394.22	374.66	335.66	412.58	323.96	228.88	521.22	366.56	427.84	235.58	739.38	350.3	273.18	472.76	334.04	533.04	306.26
306.95	297.5	195.8	206.7	289.55	195.95	356.65	299.35	275.15	309	309	472.6	260.05	527.35	329.05	310.65	382.25	254.35	461.3	334.35
210.533	199.31	173.67	248.05	212.275	186.91	233.9	196.57	131.58	255.99	203.44	264.74	137.74	436.483	200.23	156.67	259.33	170.93	308.58	166.53
575.55	536	357.25	416.75	534.05	413.15	652.45	440.45	344.6	724.95	528.05	691.45	342.85	981.55	533	372.25	688.95	470	744.15	479.65
289.1	350.2	203.8	190.4	321.3	223.8	444.3	272.6	229.2	394	334.9	531.5	231.3	617.3	364.1	227.6	438	278	476.1	296.8
139.778	86.911	83.752	143.53	104.7926	114.44	117.6704	97.481	60.311	155.51	108.39	109.5	78.656	225.841	107.32	74.348	115.1	100.61	157.33	77.015
374.549	270.5	222.16	242.336	311.1889	179.66	339.3049	270.25	276.49	328.13	291.95	359.08	194.13	453.964	327.83	273.54	322.07	242.76	417.76	338.67
177.819	139.17	112.35	103.956	155.3563	58.956	196.5563	126.13	129.82	109.76	162.09	144.24	97.819	272.706	174.26	136.54	162.65	104.83	238.53	164.56
192.147	113.49	125.41	99.7333	149.0533	73.12	201.2267	134.56	145.43	104	179.51	156	90.887	307.22	118.82	132.8	124.46	85.687	250.27	147.19
324.988	243.85	208.84	237.163	316.475	157.34	302.5	279.34	294.93	256.71	283.16	340.85	187.29	461.675	292.64	266.98	282.75	204.38	418.54	350.1
871.238	525.8	460.94	538.175	599.175	428.18	603.6	492.85	509.19	873.25	498.2	713.26	340.04	644.513	716.45	537.89	666.86	582.24	699.59	656.13
615.35	378.68	326.32	381.85	434.8333	275.28	425.4	352.63	396.02	547.53	359.22	512.17	245.67	500.333	565.9	410.57	492.13	375.85	534.1	501.45
203.5	172.55	144.45	145.525	232.1625	98.475	213.775	188.44	192.21	144.61	209.3	197.53	118.55	334.363	193.43	168.3	195.96	140.53	322.16	223.38
654.65	546.93	373.69	430.21	556.07	370.54	643.68	492.88	448.28	715.25	520.83	719.89	374.86	801.38	586.72	453.86	651.42	488.51	718.94	587.64
317.48	270.23	210.79	250.98	313.26	168.3	337.22	312.41	330.75	262.82	307.3	415.26	240.63	525.93	310.08	319.24	298.66	214.4	435.19	386.92
169.59	76.832	75.074	67.458	116.38	23.826	276.298	55.628	75.284	269.44	171.77	108.14	155.8	293.826	174.51	116.31	139.79	54.15	115.03	94.878
131.924	65.535	55.082	62.9353	114.2118	31.871	274.1765	43.094	74.835	270.44	202.86	104.82	187.27	285.212	148.53	123.88	128.55	43.253	84.094	94.594
85	32.1	28.8	37.4	100.7	35.7	253.5	15.5	47.5	200.2	207.3	84.2	192.3	226.8	82.7	96.3	103.8	15.7	54.1	79.1
192	26.083	97.467	32.4333	45.88333	9.6833	204.3833	22.383	30.583	90.183	98.35	76.533	31.367	195.617	94.833	41	65.683	14.467	93.7	41.35
217.3	148.16	88.586	112.036	184.0643	30.314	349.8929	108.05	128.31	445.19	213.89	150.39	236.45	409.771	280.48	176.28	225.53	111.91	174.11	148.68
163.133	38.725	80.292	41.875	77.04167	10.942	231.3	32.192	38.717	158.39	112.34	81.342	76.292	225.45	135.19	74.942	95.742	25.242	105.66	60.592

APPENDIX 4

Mean Precipitation During *Rabi* Season Data

		Mean Precipitation during Rabi Season									
YEAR	NAME	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PROVIN	Azad Kashmir	489.9667	330.35	410.78	198.68	125.68	335.30001	259.87	305.97	176	370.33
PROVIN	Balochistan	98.322	202.61	118.12	46.356	72.186	77.361933	90.719	58.149	81.65764	142.5
	Kalat	82.562	167.38	87.882	29.71	59.638	60.390002	73.42	38.81	59.57	136.54
	Makran	63.895	192.37	78.515	52.85	32.01	64.535	86.365	25.415	30.77	78.74
	Nasirabad	65.133	143.67	74.467	28.783	55.967	50.050001	60.867	41.417	74.25	117.77
	Quetta	93.641	223.1	112.86	47.468	73.077	77.109092	90.668	67.677	73.08636	158.33
	Sibi	104.73	196.65	119.76	46.275	87.863	73.037502	82.525	57.575	100.525	155.86
Districts	Zhob	179.98	292.5	235.23	73.05	124.56	139.05	150.47	118	151.7444	207.77
PROVIN	F.A.T.A.	308.22	265.67	353.8	191.74	139.06	284.8	279.86	268.28	197.2083	258.99
PROVIN	N.W.F.P Khyber Pakhtunwala	345.57	235.52	316.91	193.12	122.51	273.09691	257.04	263.42	158.2317	252
	Bannu	174.1	185.9	222.1	93.1	79.5	166.5	167.9	127.7	113.6	143.1
	Dera Ismail Khan	134.2	161.55	177.38	64.5	62.625	126.325	131.2	88.45	92.475	107.68
	Hazara	574.34	273.6	387.9	268.36	151.62	380.52001	316.72	375	187.98	343.94
	Kohat	253.75	248.4	319.7	147.55	109.75	245.05001	244.1	211.6	162.1	216.9
	Malakand	460.78	196.87	290.8	292.9	161.72	299.38334	305.54	372.12	169.6667	302.72
	Mardan	498.3	350.05	464.3	264.45	159.95	401	342.85	369.8	209.8	379.65
Districts	Peshawar	323.5	232.3	356.2	221	132.4	292.89999	291	299.3	172	270
PROVIN	Northern Areas/Gilgit Baltist:	328.72	107.7	175.22	115.08	71.426	172.82593	155.08	199.77	80.63704	202.43
PROVIN	Punjab	150.96	186.17	162.23	80.022	61	110.40959	104.17	85.689	78.8263	147.46
	Bahawalpur	40.963	56.456	35.763	19.138	24.569	23.6625	28.981	21.644	25.14375	39.969
	Dera Ghazi Khan	77.727	100.95	75.587	35.213	52.427	52.640001	52.413	35.12	60.38	73.62
	Faisalabad	118.53	150	121.74	64.5	53.913	82.000001	80.3	58.138	63.6125	115.35
	Gujranwala	253.01	334.69	272.14	135.44	81.388	171.95	156.16	135.24	113.8625	263.74
	Lahore	153.57	199.98	155.28	90.95	53.417	97.016669	95.733	78.517	72.96667	160.77
	Multan	73.75	92.487	63.738	38.425	39.2	45.687501	43.25	34.775	44.175	67.713
	Rawalpindi	334.46	366.16	387.1	176.55	115.92	280.64	247.31	230.23	162.8	317.5
Districts	Sargodha	155.68	188.67	186.47	79.96	67.17	129.68	129.18	91.85	87.67	140.99
PROVIN	Sind	48.598	33.284	29.503	4.8619	19.865	13.578193	14.423	3.4795	14.32658	35.465
	Hyderabad	50.076	32.553	35.112	3.9824	23.524	15.458824	14.988	2.8176	12.43529	33.941
	Karachi	105.4	42.4	50.5	2.7	38.8	20	16.2	1.9	16.9	57.7
	Larkana	40.95	53.683	26.517	9.3333	16.9	17.516667	22.417	8.2833	28.91667	51.617
	Mirpur Khas	17.014	10.9	15.443	2.9857	7.7786	4.8071429	6.5357	1.3214	2.264286	7.8571
Districts	Sukkur	29.55	26.883	19.942	5.3083	12.325	10.108334	11.975	3.075	11.11667	26.208

YEAR	NAME	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
PROVIN	Azad Kashmir	318.17	429.05	263.97	296.6	265	414.1	201.95	370.85	319.9	160.87	121.27
PROVIN	Balochistan	149.46	139.68	77.275	63.694	77.207	100.21	107.6	107.84	76.22	24.225	40.038
	Kalat	112.65	115.83	68.536	44.008	57.896	104.79	101.59	102.51	68.196	23.102	29.154
	Makran	68.24	83.69	33.41	30.53	41.235	69.175	98.975	60.395	54.57	7.405	7.585
	Nasirabad	101	99.017	55.883	34.2	49.4	70.917	75.733	92.033	51.283	17.75	33.2
	Quetta	166.3	130.54	93.573	77.109	68.505	128.63	100.27	114.73	85.036	24.991	37.818
	Sibi	152.68	148.25	77.988	57.438	84.738	91.575	110.14	114.35	74.725	25.738	52.688
Districts	Zhob	295.87	260.74	134.26	138.88	161.47	136.2	158.87	163.04	123.51	46.367	79.783
PROVIN	F.A.T.A.	356.36	383.08	223.81	279.12	277.72	262.73	271.42	336.86	218.42	96.675	138.34
PROVIN	N.W.F.P Khyber Pakhtunwala	302.27	343.19	201.7	255.76	240.1	279.99	215.08	318.44	240.97	107.81	118.49
	Bannu	217.1	245.3	141.4	158.5	174.6	143.8	165	181.5	112.7	46.9	88.7
	Dera Ismail Khan	185.85	198.13	110.95	121.75	141.65	102.93	124.58	125.3	84.05	32.9	68.575
	Hazara	369.22	431.36	256.34	347.82	284.1	445.66	229.78	440.3	390.74	177.22	145.38
	Kohat	300.9	348.35	202.5	233.5	245.85	220.7	241.15	283.25	174.8	72.7	122.2
	Malakand	357.77	348.41	218.04	311.24	260.64	382.98	215.82	426.15	369.02	175.85	138.41
	Mardan	384.95	475.4	277.15	342.2	317.45	392.95	281.75	435.25	323.9	153.9	147.05
Districts	Peshawar	300.1	355.4	205.5	275.3	256.4	270.9	247.5	337.3	231.6	95.2	119.1
PROVIN	Northern Areas/Gilgit Baltist:	183.91	216.16	131.29	197.47	128.23	315.02	83.381	246.79	259.63	86.515	61.856
PROVIN	Punjab	140.5	167.74	99.189	82.221	132.96	106.16	103.5	118.51	86.664	49.048	47.012
	Bahawalpur	41.388	42.813	24.513	22.05	41.556	30.806	33.338	46.15	24.969	13.563	14.056
	Dera Ghazi Khan	95.3	86.96	54.073	43.78	77.293	53.187	63.6	62.347	53.593	23.5	28.34
	Faisalabad	115.65	125.44	80	58.5	111.03	76.138	79.575	84.875	69.963	38.113	34.85
	Gujranwala	202.84	264.94	154.06	112.69	211.43	173.09	148.08	169.58	132.59	90.338	63.363
	Lahore	120.87	139.97	87.283	61.367	137.38	92.367	91.867	95.667	76.3	49.217	37.817
	Multan	70.938	68.375	45.638	32.588	71.95	47.513	47.675	54.788	46	26.475	18.4
	Rawalpindi	306.4	409.31	228.83	219.76	264.37	262.22	237.07	298.83	196.91	108.25	114.82
Districts	Sargodha	170.63	204.13	119.11	107.04	148.71	113.96	126.8	135.83	92.99	42.93	64.45
PROVIN	Sind	18.015	27.831	23.293	11.435	16.775	24.063	34.75	26.905	16.7	7.2927	8.1216
	Hyderabad	18.312	27.947	27.676	13.406	17.212	22.465	36.282	25.529	16	6.5471	8.9294
	Karachi	27.7	44.5	36.1	14.8	25.7	48.7	57.2	30.6	19.1	19.2	6.3
	Larkana	27.3	36.683	21.3	14.817	20.25	30.6	39.167	38.883	25.8	6.5667	11.717
	Mirpur Khas	3.3571	9.5429	13.757	5.1857	7.3286	4.1857	16.693	15.286	7.0429	0.85	5.7286
Districts	Sukkur	13.408	20.483	17.633	8.9667	13.383	14.367	24.408	24.225	15.558	3.3	7.9333

Mean Precipitation During *Rabi* Season Data (continued)

YEAR	NAME	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
PROVINCE	Azad Kashmir	236.5	429.6	286.5	386.9	291.3	264.6	241.7	344.2	214.1	283.6	255.0	315.4	376.5	510.6	268.6
PROVINCE	Balochistan	48.3	66.9	48.4	123.5	37.4	108.6	71.1	96.4	49.0	132.3	69.7	137.5	79.5	89.9	67.6
	Kalat	27.9	57.7	38.5	102.4	22.0	88.3	63.5	67.3	37.1	124.4	44.5	119.2	58.2	51.6	44.9
	Makran	7.4	33.6	21.4	80.8	19.5	31.2	26.9	71.9	36.9	63.8	26.1	79.7	57.5	42.4	31.4
	Nasirabad	37.8	45.6	40.9	76.4	25.6	99.4	51.8	74.5	34.4	115.3	47.9	132.5	43.6	77.9	44.3
	Quetta	37.5	77.6	40.0	141.7	27.4	90.4	87.1	82.7	41.0	138.9	77.2	87.7	77.5	63.1	63.1
	Sibi	57.7	66.8	56.7	118.1	45.0	142.9	77.6	106.8	57.6	151.3	71.1	188.3	75.8	119.4	73.7
Districts	Zhob	121.4	120.4	92.6	221.5	85.0	199.5	119.7	175.2	87.4	199.9	151.3	217.4	164.2	184.6	148.2
PROVINCE	F.A.T.A.	224.9	327.1	228.5	351.5	212.1	310.2	234.6	399.7	217.1	285.8	306.1	370.0	363.4	420.9	295.7
PROVINCE	N.W.F.P Khyber Pal	211.2	329.7	228.6	334.6	218.4	260.4	213.7	347.0	202.1	247.6	242.5	318.8	315.5	385.8	251.4
	Bannu	119.4	162.5	115.4	214.1	113.0	198.7	133.7	201.8	108.5	158.8	170.2	201.3	246.2	259.9	165.7
	Dera Ismail Khan	87.9	104.0	76.3	174.4	81.7	153.1	96.0	133.2	70.9	112.0	116.7	144.9	189.7	185.5	122.2
	Hazara	297.3	481.1	320.8	450.8	338.9	290.2	266.0	445.2	291.6	339.9	309.8	410.6	379.6	506.0	320.1
	Kohat	181.2	272.2	193.8	307.7	175.2	282.9	207.9	331.5	173.3	236.8	257.4	306.8	344.2	387.5	251.1
	Malakand	275.7	406.7	278.7	403.5	296.7	265.9	245.6	409.4	280.1	309.4	285.6	378.0	298.6	387.6	318.6
	Mardan	292.1	493.2	343.8	449.0	306.4	348.0	303.1	484.2	274.6	333.7	314.6	430.9	420.9	555.5	317.1
Districts	Peshawar	224.8	388.5	271.5	342.7	216.8	284.0	243.7	424.1	215.6	242.5	243.3	359.1	329.6	418.5	265.2
PROVINCE	Northern Areas/Gil	158.1	291.7	204.2	264.6	214.6	105.6	116.3	196.3	182.7	181.0	182.6	152.3	182.5	248.4	190.2
PROVINCE	Punjab	59.6	130.4	83.6	163.7	79.8	147.6	108.6	117.8	53.9	89.3	86.2	119.1	145.9	181.4	92.9
	Bahawalpur	14.9	34.1	21.0	50.8	24.5	64.1	41.5	26.7	16.8	29.8	19.8	44.3	38.4	56.1	24.1
	Dera Ghazi Khan	37.6	47.4	31.9	99.7	49.6	90.6	68.1	65.4	39.8	63.6	40.0	83.3	75.6	88.3	61.4
	Faisalabad	40.5	91.7	54.6	144.5	63.8	117.1	91.4	86.4	38.9	65.3	62.9	81.1	117.4	135.2	72.0
	Gujranwala	73.4	220.1	132.3	241.4	112.0	220.4	153.2	168.0	57.4	120.7	134.0	174.0	212.5	281.0	127.2
	Lahore	33.1	127.9	67.2	159.3	64.8	142.5	88.6	100.8	29.9	65.5	78.2	103.4	122.9	159.5	68.7
	Multan	24.3	54.5	29.9	95.7	45.3	82.1	64.4	50.4	26.3	41.4	31.6	48.1	67.9	81.0	45.0
	Rawalpindi	175.8	337.0	239.8	329.9	188.8	300.6	240.8	305.9	151.9	219.6	213.3	282.9	340.6	438.1	227.9
Districts	Sargodha	76.9	130.4	91.9	188.5	89.5	163.7	120.6	139.0	70.4	108.9	109.8	136.1	191.7	212.1	116.6
PROVINCE	Sind	5.6	21.2	11.2	20.8	15.1	52.4	22.7	13.1	9.2	21.5	4.0	73.5	17.6	20.7	15.6
	Hyderabad	4.9	21.1	10.4	20.0	15.1	53.6	24.6	10.7	9.1	20.1	3.5	77.3	18.8	16.7	15.6
	Karachi	4.7	36.0	18.6	31.0	9.4	71.0	21.3	8.6	6.5	21.1	2.0	96.5	21.0	12.4	12.3
	Larkana	12.4	22.9	17.9	29.8	14.7	60.5	19.8	31.1	14.7	44.1	8.8	82.4	16.7	40.3	18.0
	Mirpur Khas	0.7	9.5	2.0	7.3	21.2	31.5	27.4	2.2	4.9	2.8	1.9	50.5	16.9	12.6	17.3
Districts	Sukkur	5.3	16.4	7.3	15.9	15.1	45.4	20.4	12.8	10.9	19.6	4.1	60.9	14.4	21.7	14.9

APPENDIX 5

Mean Temperature During *Kharif* Season Data

Mean Temperature during Kharif Season

YEAR		1981	1982	1983	1984	1985	1986	1987	1988
PROVINCE	Azad Kashmir	16.35000038	16.57333	16.46667	16.78	16.88667	16.5533334	16.90667	16.76667
PROVINCE	Balochistan	27.48500046	27.68387	28.28113	27.350484	27.16581	27.330323	27.94968	28.22936
	Kalat	27.65840038	27.8684	28.4892	27.4084	27.2236	27.4984004	28.1232	28.4
	Makran	28.94000053	29.256	29.64	28.429	28.149	28.5550003	28.962	29.184
	Nasirabad	31.32666683	31.38333	31.97667	31.2	31.07333	31.0533333	31.92333	32.14
	Quetta	27.31363687	27.57364	28.60182	27.583637	27.28546	27.4727278	27.83727	28.42546
	Sibi	28.0800004	28.14	28.5175	27.940001	27.87	27.7800002	28.7625	28.845
Districts	Zhob	24.05111175	24.12333	24.46445	24.161111	24.15111	23.8877783	24.79444	24.87778
PROVINCE	F.A.T.A	24.345455	24.58182	24.57273	24.654546	24.87818	24.5709093	25.24545	25.06545
PROVINCE	N.W.F.P./Khyber-Pakhtunwala	19.08571463	19.345	19.39	19.67	19.81214	19.5200004	19.71643	19.79429
	Bannu	29.96000099	30.22	30.02	24.951667	30.36	30.0600014	30.92	30.54
	Dera Ismail Khan	30.15500069	30.425	30.2	30.1	30.42	30.1350012	31.13	30.76
	Hazara	14.77200012	15.008	15.016	30.175	15.516	15.1920002	15.328	15.4
	Kohat	26.9800005	27.25	27.08	15.4	27.44	27.1599998	27.95	27.58
	Malakand	12.21500035	12.47167	12.725	27.15	13.195	12.9116668	12.62667	13.06667
	Mardan	26.35999966	26.64	26.53	13.138334	26.98	26.7000008	27.07	26.88
Districts	Peshawar	28.68000031	28.96	28.96	26.78	29.44	29.1400013	29.46	29.4
PROVINCE	Northern Areas- Gilgit Baltistan	7.547407512	7.774074	7.948889	29.220001	8.427408	8.07333354	7.854815	8.154074
PROVINCE	Punjab	30.62246977	30.85877	30.4321	30.322469	30.50691	30.3158029	31.4484	30.85259
	Bahawalpur	31.77750087	31.90625	31.4425	31.0775	31.29125	31.2200004	32.61375	31.91125
	Dera Ghazi Khan	30.95733401	31.088	30.844	30.6	30.70533	30.5280004	31.72	31.37467
	Faisalabad	31.12750077	31.4375	30.8625	30.855	31.045	30.8350008	31.9625	31.275
	Gujranwala	29.29500079	29.6375	29.205	29.27	29.435	29.1550002	30.0675	29.445
	Lahore	30.58666674	30.95333	30.33333	30.313334	30.46333	30.2933337	31.40333	30.58
	Multan	31.89000082	32.1475	31.515	31.352501	31.5425	31.4025006	32.705	31.9275
	Rawalpindi	28.15400028	28.426	28.176	28.298	28.524	28.2300005	29.012	28.548
Districts	Sargodha	30.40600052	30.698	30.284	30.32	30.562	30.2940002	31.328	30.772
PROVINCE	Sind	31.27960064	31.4508	31.4608	30.36	30.6376	30.8488005	32.0468	31.7744
	Hyderabad	30.70000043	30.92118	31.02235	29.794118	30.06588	30.3282357	31.44706	31.26118
	Karachi	29.47999954	29.74	29.92	28.66	28.78	29.1200008	30.04	30.08
	Larkana	32.79333433	32.92667	33.16	32.273333	32.31	32.3766673	33.38667	33.42667
	Mirpur Khas	30.75142901	30.90857	30.70143	29.591429	30.03857	30.2914291	31.68571	31.12
Districts	Sukkur	32.11000109	32.23833	32.24667	31.243334	31.465	31.6166671	32.815	32.58

YEAR		1989	1990	1991	1992	1993	1994	1995	1996
PROVINCE	Azad Kashmir	16.2433	17.05	16.667	16.213	16.52	16.37	16.68	16.15
PROVINCE	Balochistan	27.411	27.934	27.672	27.283	27.661	27.387	28.147	27.588
	Kalat	27.6048	27.964	27.785	27.486	27.908	27.53	28.348	27.794
	Makran	28.671	28.916	28.688	28.624	28.928	28.571	29.304	28.616
	Nasirabad	31.04	31.823	31.633	31.177	31.567	31.233	31.967	31.52
	Quetta	27.7	28.179	27.721	27.167	27.468	27.618	28.362	27.737
	Sibi	27.715	28.593	28.438	27.87	28.26	27.883	28.638	28.16
Districts	Zhob	23.7744	24.869	24.507	23.81	24.237	23.887	24.547	24.123
PROVINCE	F.A.T.A	24.3436	25.278	24.747	24.069	24.415	23.973	24.505	24.055
PROVINCE	N.W.F.P./Khyber-Pakhtunwala	19.185	20.064	19.464	18.921	19.21	18.971	19.369	18.909
	Bannu	29.86	30.74	30.32	29.64	30.04	29.54	30.1	29.62
	Dera Ismail Khan	29.945	30.95	30.59	29.87	30.33	29.845	30.44	29.995
	Hazara	14.84	15.652	15.108	14.64	14.908	14.716	15.06	14.584
	Kohat	26.96	27.78	27.34	26.69	27.04	26.56	27.08	26.63
	Malakand	12.4867	13.387	12.602	12.102	12.32	12.248	12.545	12.09
	Mardan	26.41	27.19	26.72	26.24	26.54	26.21	26.65	26.18
Districts	Peshawar	28.76	29.64	29.08	28.56	28.82	28.48	28.92	28.44
PROVINCE	Northern Areas- Gilgit Baltistan	7.51185	8.5096	7.8474	7.4793	7.6719	7.8978	7.9711	7.4889
PROVINCE	Punjab	30.1842	30.825	30.86	30.311	30.76	30.211	30.892	30.238
	Bahawalpur	31.1213	31.57	31.873	31.359	31.86	31.1	32.043	31.254
	Dera Ghazi Khan	30.4173	31.209	31.225	30.621	31.072	30.497	31.279	30.693
	Faisalabad	30.665	31.335	31.393	30.805	31.288	30.76	31.365	30.723
	Gujranwala	29.005	29.633	29.568	29.115	29.5	29.158	29.593	28.928
	Lahore	30.1933	30.653	30.827	30.37	30.777	30.337	30.9	30.167
	Multan	31.275	31.848	32.085	31.513	32.025	31.37	32.158	31.413
	Rawalpindi	28.054	28.79	28.47	27.958	28.318	27.934	28.406	27.878
Districts	Sargodha	30.146	30.922	30.726	30.09	30.538	30.036	30.6	30.056
PROVINCE	Sind	30.7676	30.907	31.098	31.022	31.631	30.6	31.656	31.032
	Hyderabad	30.2671	30.311	30.472	30.471	31.146	30.08	31.12	30.546
	Karachi	29.12	29.1	29.26	29.28	29.86	28.86	29.82	29.34
	Larkana	32.2733	32.847	32.907	32.583	33.02	32.353	33.233	32.733
	Mirpur Khas	30.21	30.149	30.414	30.471	31.157	29.949	31.121	30.36
Districts	Sukkur	31.5117	31.817	32.033	31.81	32.325	31.363	32.405	31.795

YEAR		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
PROVIN	Azad Kas	16.333	17.0767	17.593	16.97	16.813	16.80333	16.75	16.36	17.04	16.763
PROVIN	Balochis	27.677	28.1971	28.364	27.78	28.195	28.19887	28.123	27.819	28.418	28.61
	Kalat	27.874	28.4256	28.466	27.917	28.392	28.3592	28.307	28.061	28.63	28.944
	Makran	28.885	29.209	29.342	28.813	29.403	29.176	29.335	28.953	29.525	29.735
	Nasirabac	31.417	32.11	32.14	31.817	31.953	32.07333	31.853	31.573	32.143	32.3
	Quetta	28.023	28.4691	28.666	27.763	28.565	28.59727	28.433	28.075	28.805	29.093
	Sibi	27.973	28.7125	28.863	28.558	28.513	28.745	28.478	28.215	28.763	28.8
Districts	Zhob	23.989	24.5722	25.144	24.582	24.464	24.64667	24.487	24.149	24.731	24.532
PROVIN	F.A.T.A	24.018	24.6382	25.631	24.655	24.355	24.65273	24.651	24.344	24.967	24.578
PROVIN	N.W.F.P./	19.054	19.6514	20.426	19.621	19.437	19.64714	19.593	19.248	19.903	19.614
	Bannu	29.56	30.22	31.22	30.28	29.92	30.22	30.14	29.8	30.44	29.94
	Dera Isma	29.77	30.42	31.285	30.62	30.31	30.51	30.395	30.04	30.63	30.195
	Hazara	14.74	15.42	16.104	15.36	15.184	15.292	15.268	14.88	15.564	15.268
	Kohat	26.59	27.26	28.26	27.26	26.92	27.21	27.21	26.83	27.5	27.07
	Malakand	12.443	12.93	13.655	12.837	12.763	13.005	12.955	12.642	13.295	13.13
	Mardan	26.21	26.93	27.66	26.86	26.61	26.76	26.69	26.32	27.01	26.64
Districts	Peshawar	28.52	29.22	30.06	29.12	28.82	29.08	29.04	28.7	29.36	28.98
PROVIN	Northern	7.9748	8.54074	9.0207	8.4111	8.4156	8.42963	8.4059	8.1052	8.6822	8.6511
PROVIN	Punjab	29.942	30.9598	31.328	30.953	30.618	31.00691	30.598	30.333	30.902	30.584
	Bahawalp	30.75	31.98	32.056	31.938	31.484	32.22875	31.468	31.454	31.83	31.624
	Dera Gha:	30.333	31.2787	31.595	31.329	30.988	31.42267	31.012	30.783	31.237	31.044
	Faisalaba	30.445	31.415	31.918	31.478	31.14	31.44	31.098	30.748	31.408	31.003
	Gujranwal	28.865	29.835	30.235	29.745	29.545	29.6525	29.448	28.993	29.76	29.358
	Lahore	29.907	31.0267	31.27	30.93	30.693	30.95333	30.543	30.203	30.91	30.523
	Multan	30.953	32.1625	32.36	32.143	31.738	32.295	31.66	31.478	32.003	31.688
	Rawalpin	27.818	28.638	29.294	28.6	28.338	28.488	28.374	27.978	28.678	28.278
Districts	Sargodha	29.86	30.704	31.412	30.778	30.454	30.686	30.512	30.122	30.762	30.334
PROVIN	Sind	30.878	31.6936	31.443	31.428	31.21	31.5952	31.362	31.36	31.585	31.732
	Hyderaba	30.5	31.1682	30.927	30.873	30.747	30.96	30.918	30.878	31.104	31.315
	Karachi	29.46	29.94	29.8	29.6	29.7	29.6	29.82	29.72	30.04	30.36
	Larkana	32.593	33.3667	33.26	33.087	33.05	33.37667	33.033	32.9	33.357	33.533
	Mirpur Kh	30.127	31.0629	30.707	30.813	30.419	30.97	30.636	30.75	30.811	30.86
Districts	Sukkur	31.552	32.4833	32.262	32.255	31.995	32.5	32.133	32.122	32.413	32.553

YEAR		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
PROVIN	Azad Kas	16.813	17.043	17.09	16.487	17.107	16.973	17.823	17.483	16.67	17.61
PROVIN	Balochis	27.606	28.538	28.412	28.17	28.52	27.983	29.199	29.277	28.55	28.992
	Kalat	27.815	28.838	28.652	28.47	28.738	28.193	29.387	29.47	28.817	29.118
	Makran	28.948	29.854	29.841	29.425	29.759	29.169	30.196	30.372	29.96	30.034
	Nasirabac	31.423	32.02	32.007	31.897	32.163	31.75	32.917	32.887	32.027	32.72
	Quetta	27.541	29.087	28.583	28.425	28.936	28.166	29.706	29.771	29.008	29.468
	Sibi	28.145	28.523	28.648	28.463	28.743	28.418	29.51	29.485	28.548	29.392
Districts	Zhob	24.1	24.418	24.642	24.259	24.713	24.408	25.569	25.623	24.522	25.486
PROVIN	F.A.T.A	24.511	24.851	25.087	24.22	24.851	24.729	25.713	25.824	24.616	25.704
PROVIN	N.W.F.P./	19.551	19.946	19.841	19.224	19.898	19.686	20.515	20.411	19.585	20.456
	Bannu	30.02	30.22	30.6	29.72	30.36	30.24	31.3	31.46	30.16	31.3
	Dera Isma	30.18	30.285	30.75	30.035	30.57	30.44	31.41	31.565	30.31	31.405
	Hazara	15.268	15.628	15.516	14.876	15.564	15.376	16.176	15.976	15.22	16.096
	Kohat	27.1	27.36	27.66	26.76	27.39	27.34	28.35	28.42	27.11	28.24
	Malakand	12.96	13.545	13.048	12.6	13.348	13.025	13.775	13.533	13.022	13.688
	Mardan	26.7	26.95	27.1	26.34	26.97	26.87	27.65	27.63	26.62	27.65
Districts	Peshawar	29.04	29.42	29.52	28.7	29.32	29.2	30.04	30.08	29	30.06
PROVIN	Northern	8.5541	8.957	8.7015	8.1378	8.977	8.6044	9.4089	8.8904	8.4504	9.0563
PROVIN	Punjab	30.66	30.566	31.094	30.528	30.78	30.828	31.444	31.504	30.516	31.502
	Bahawalp	31.721	31.545	32.16	31.691	31.73	31.771	32.243	32.364	31.505	32.394
	Dera Gha:	30.911	30.848	31.328	30.921	31.177	31.077	31.828	31.879	30.872	31.853
	Faisalaba	31.143	30.98	31.568	30.94	31.208	31.363	31.92	32.025	30.958	32.003
	Gujranwal	29.51	29.428	29.895	29.295	29.613	29.74	30.295	30.293	29.35	30.33
	Lahore	30.713	30.497	31.12	30.557	30.697	30.93	31.303	31.403	30.5	31.413
	Multan	31.838	31.618	32.26	31.74	31.853	31.985	32.418	32.52	31.595	32.568
	Rawalpin	28.356	28.492	28.816	28.066	28.566	28.564	29.386	29.32	28.248	29.314
Districts	Sargodha	30.45	30.43	30.95	30.206	30.662	30.666	31.49	31.552	30.394	31.472
PROVIN	Sind	31.528	31.64	31.917	31.739	31.544	31.48	31.894	32.165	31.739	31.882
	Hyderaba	31.031	31.239	31.436	31.291	31.08	30.985	31.424	31.738	31.412	31.34
	Karachi	29.92	30.24	30.26	30.22	30.04	29.88	30.46	30.64	30.36	30.22
	Larkana	32.907	33.233	33.363	33.23	33.317	33.057	33.923	33.92	33.15	33.8
	Mirpur Kh	31.014	30.876	31.346	31.114	30.747	30.854	30.903	31.361	31.09	31.04
Districts	Sukkur	32.278	32.422	32.68	32.485	32.37	32.255	32.82	32.957	32.37	32.813

APPENDIX 6

Mean Temperature During *Rabi* Season Data

									Mean temperature during Rabi Season								
YEAR	NAME	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
PROVINCE	Azad Kashmir	4.7958	3.2542	2.85	4.3125	5.3958	3.3458	4.6333	5.2833	3.4625	4.4	3.0958	3.6375	4.3458	4.3167	3.1708	4.6333
PROVINCE	Balochistan	16.496	14.636	14.436	15.557	16.46	14.974	16.461	16.669	14.434	15.935	15.17	14.847	16.194	15.963	15.321	16.148
	Kalat	17.017	15.221	15	16.095	16.949	15.565	16.946	17.2	15.009	16.55	15.696	15.407	16.82	16.528	15.921	16.673
	Makran	20.601	18.815	18.503	19.653	20.165	18.994	20.116	20.333	18.498	19.935	19.321	18.558	20.415	19.929	19.215	20.001
	Nasirabad	19.696	17.846	17.675	18.921	19.979	18.404	19.892	20.217	17.879	19.238	18.471	18.442	19.492	19.346	18.779	19.717
	Quetta	15.097	13.027	12.897	13.823	14.806	13.176	14.995	14.924	12.516	14.281	13.565	13.14	14.465	14.344	13.685	14.297
	Sibi	16.444	14.556	14.419	15.697	16.784	15.147	16.703	17.038	14.713	15.959	15.269	15.241	16.188	16.125	15.484	16.559
Districts	Zhob	11.158	9.3	9.1639	10.453	11.689	9.8417	11.593	11.913	9.3917	10.625	9.9139	9.8819	10.781	10.768	10.104	11.301
PROVINCE	F.A.T.A.	11.616	10.007	9.7705	11.161	12.423	10.445	12.15	12.486	10.127	11.209	10.207	10.218	11.1	10.97	10.134	11.514
PROVINCE	N.W.F.P Khyber Pakhtun	6.5455	4.967	4.6446	5.883	7.0482	5.2429	6.6116	7.0063	4.8786	6.0214	4.8446	5.0786	5.8911	5.7679	4.8196	6.0931
	Bannu	17.4	15.775	15.575	17	18.175	16.175	17.975	18.375	16.025	17.05	16.05	16.1	17	16.925	16.05	17.45
	Dera Ismail Khan	17.606	15.862	15.738	17.131	18.269	16.363	18.169	18.525	16.037	17.1	16.35	16.35	17.288	17.225	16.463	17.838
	Hazara	2.865	1.285	0.875	2.34	3.42	1.48	2.715	3.275	1.285	2.395	1.045	1.41	2.205	2.155	1.075	2.43
	Kohat	14.663	13.075	12.8	14.25	15.475	13.463	15.213	15.6	13.325	14.313	13.275	13.338	14.238	14.088	13.175	14.625
	Malakand	-0.8125	-2.3396	-2.6937	-1.7542	-0.55	-2.1292	-0.9812	-0.6854	-2.7229	-1.4458	-2.7188	-2.4333	-1.6771	-1.8771	-2.8292	-1.7042
	Mardan	14.738	13.188	12.8	14.363	15.45	13.4	14.8	15.363	13.338	14.3	13.05	13.4	14.175	14.15	13.138	14.575
Districts	Peshawar	16.275	14.7	14.325	15.875	17.025	15	16.425	16.95	14.775	15.825	14.55	14.775	15.625	15.575	14.575	16
PROVINCE	Northern Areas/Gilgit B:	-5.7204	-6.962	-7.6444	-6.6398	-5.6185	-7.0991	-6.0861	-5.7333	-7.3315	-6.2833	-7.5389	-7.0185	-6.3009	-6.5222	-7.8583	-6.5065
PROVINCE	Punjab	19.159	17.433	17.236	18.608	19.638	17.98	19.446	19.894	17.78	18.725	17.962	18.182	18.966	18.991	18.088	19.513
	Bahawalpur	20.559	18.811	18.636	19.92	20.889	19.575	20.903	21.314	19.211	20.191	19.569	19.63	20.469	20.558	19.698	21.044
	Dera Ghazi Khan	19.065	17.208	17.053	18.405	19.443	17.88	19.365	19.783	17.508	18.558	17.938	17.997	18.857	18.833	18.095	19.407
	Faisalabad	19.575	17.822	17.653	19.034	20.028	18.338	19.825	20.297	18.147	19.053	18.344	18.625	19.384	19.428	18.469	19.963
	Gujranwala	18.484	16.906	16.619	18.044	19.094	17.197	18.606	19.144	17.259	18.103	17.125	17.631	18.25	18.294	17.253	18.766
	Lahore	19.667	18.021	17.833	19.163	20.175	18.492	19.904	20.362	18.417	19.268	18.454	18.929	19.554	19.633	18.617	20.036
	Multan	20.034	18.284	18.134	19.444	20.4	18.916	20.353	20.756	18.6	19.553	18.959	19.175	19.95	20.028	19.119	20.563
	Rawalpindi	16.788	15.18	14.888	16.375	17.543	15.485	17.033	17.565	15.558	16.438	15.318	15.663	16.435	16.41	15.41	16.91
Districts	Sargodha	18.635	16.893	16.7	18.155	19.218	17.355	19.015	19.428	17.205	18.152	17.345	17.505	18.355	18.298	17.398	18.878
PROVINCE	Sind	22.488	21.114	20.849	21.905	22.631	21.741	22.714	23.236	21.296	22.284	21.529	21.43	22.616	22.429	21.805	22.749
	Hyderabad	22.59	21.301	21.034	22.028	22.674	21.821	22.759	23.315	21.381	22.401	21.603	21.491	22.794	22.519	21.954	22.787
	Karachi	22.5	21.2	20.95	21.875	22.55	21.525	22.55	23.075	21.225	22.3	21.45	21.3	22.7	22.3	21.8	22.525
	Larkana	22.192	20.479	20.308	21.517	22.433	21.079	22.338	22.713	20.596	21.754	21.046	21.021	22.063	21.896	21.321	22.321
	Mirpur Khas	22.946	21.77	21.427	22.427	23.071	22.5	23.293	23.882	22.046	22.898	22.188	22.005	23.198	23.109	22.395	23.405
Districts	Sukkur	21.954	20.394	20.175	21.317	22.16	21.092	22.177	22.646	20.654	21.665	20.904	20.888	21.954	21.785	21.148	22.16

YEAR	NAME	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
PROVIN	Azad K:	3.7042	4.2417	5.2375	4.7167	5.2583	5.0708	4.6042	6.3875	4.05	5.6125	5.4667	4.5625	5.525	6.4625	4.4917	3.65	4.2583	4.3333	4.3708	5.5
PROVIN	Balochi	15.203	16.236	16.473	16.622	16.142	16.693	17.067	18.064	15.679	17.071	16.895	15.713	16.944	18.176	16.38	15.27	15.478	15.692	16.578	17.675
	Kalat	15.782	16.823	17.044	17.172	16.646	17.249	17.795	18.591	16.274	17.568	17.606	16.213	17.541	18.681	16.97	15.88	16.019	16.257	17.242	18.334
	Makran	19.253	20.055	20.095	20.636	19.679	20.48	21.28	21.693	19.865	20.604	20.901	19.645	20.691	21.998	20.7	19.678	19.546	19.519	20.633	21.736
	Nasirabac	18.512	19.671	20.038	19.95	19.763	20.171	20.225	21.625	18.846	20.633	20.167	19.175	20.429	21.567	19.429	18.371	18.846	19.179	19.65	20.971
	Quetta	13.673	14.782	14.93	15.119	14.536	15.184	15.611	16.556	14.173	15.576	15.326	13.959	15.351	16.767	14.843	13.695	13.87	13.978	15.292	16.115
	Sibi	15.213	16.366	16.741	16.65	16.553	16.863	16.766	18.369	15.541	17.428	16.794	16.003	17.181	18.338	16.125	15.078	15.641	15.972	16.291	17.628
Districts	Zhob	9.8569	10.939	11.443	11.347	11.388	11.55	11.224	13.089	10.224	12.244	11.343	10.813	11.803	13.047	10.915	9.6583	10.228	10.678	10.903	12.158
PROVIN	F.A.T.A	10.086	10.789	11.702	11.448	11.802	11.684	11.252	13.234	10.668	12.655	11.923	11.502	12.05	13.241	11.434	9.975	10.325	11.039	10.714	11.905
PROVIN	N.W.F.F	5.2036	5.7018	6.6491	6.3339	6.7589	6.6473	6.1277	7.9884	5.6554	7.2625	6.9804	6.1786	6.9366	8.0366	6.1911	4.9063	5.6446	5.9813	5.8411	6.8768
	Bannu	15.975	16.75	17.625	17.35	17.7	17.55	17.1	19.075	16.45	18.45	17.625	17.35	17.925	19.15	17.225	15.9	16.05	16.8	16.5	17.85
	Dera Isma	16.3	17.213	17.881	17.731	17.938	17.963	17.406	19.431	16.619	18.725	17.7	17.469	18.194	19.5	17.425	16.144	16.538	17.044	16.919	18.25
	Hazara	1.58	2.085	3.07	2.655	3.13	2.97	2.515	4.29	1.975	3.56	3.35	2.57	3.26	4.41	2.47	1.345	2.095	2.38	2.205	3.07
	Kohat	13.213	13.887	14.825	14.525	14.9	14.75	14.338	16.25	13.663	15.712	14.963	14.6	15.125	16.35	14.488	13.113	13.213	14.125	13.675	14.963
	Malakand	-2.15	-1.8854	-0.8833	-1.1729	-0.7146	-0.8146	-1.3896	0.4312	-1.6313	-0.3792	-0.2438	-1.4479	-0.5292	0.3917	-1.2875	-2.6604	-1.5188	-1.4396	-1.4229	-0.5479
	Mardan	13.35	13.988	15.038	14.55	15.1	14.887	14.413	16.287	13.8	15.625	15.163	14.6	15.188	16.45	14.463	13.35	13.713	14.25	13.9	15.138
Districts	Peshawar	14.75	15.325	16.375	15.925	16.475	16.25	15.875	17.675	15.25	17.15	16.65	16.1	16.6	17.9	15.95	14.7	15.025	15.75	15.3	16.5
PROVIN	Norther	-6.4046	-6.3722	-5.4583	-5.8769	-5.3454	-5.6065	-6.0556	-4.3417	-6.312	-5.3843	-4.6306	-6.5093	-4.8972	-4.3944	-6.2009	-7.1528	-5.8509	-6.1565	-5.8139	-5.0111
PROVIN	Punjab	18.115	18.965	19.623	19.293	19.518	19.692	19.034	20.944	18.331	20.248	19.542	19	19.945	21.148	18.938	18.091	18.557	18.662	18.637	20.145
	Bahawalp	19.625	20.563	20.98	20.752	20.808	21.12	20.591	22.388	19.758	21.589	21.017	20.4	21.534	22.658	20.323	19.58	20.259	20.181	20.306	21.817
	Dera Gha:	17.912	18.945	19.42	19.243	19.345	19.54	19.06	20.963	18.138	20.12	19.333	18.785	19.802	20.987	18.742	17.815	18.437	18.638	18.618	20.145
	Faisalaba	18.569	19.384	20.059	19.741	19.969	20.166	19.3	21.344	18.744	20.691	19.881	19.422	20.328	21.584	19.378	18.559	18.897	19.019	18.897	20.466
	Gujranwal	17.5	18.178	19.109	18.537	18.969	19.094	18.325	20.209	17.759	19.653	19.031	18.388	19.269	20.434	18.347	17.55	17.894	17.834	17.903	19.419
	Lahore	18.812	19.521	20.346	19.8	20.1	20.413	19.488	21.392	19.004	20.863	20.15	19.613	20.579	21.804	19.488	18.883	19.183	19.088	19.121	20.742
	Multan	19.138	20.041	20.591	20.259	20.403	20.664	19.938	21.844	19.222	21.141	20.4	19.891	20.941	22.169	19.803	19.122	19.638	19.568	19.566	21.175
	Rawalpin	15.593	16.275	17.218	16.793	17.228	17.165	16.558	18.485	15.965	17.875	17.253	16.71	17.405	18.638	16.625	15.593	15.9	16.265	16.07	17.395
Districts	Sargodha	17.418	18.233	19.015	18.703	19.025	19.035	18.34	20.348	17.715	19.705	18.87	18.448	19.213	20.5	18.425	17.377	17.69	18.045	17.905	19.36
PROVIN	Sind	21.539	22.521	22.821	22.642	22.603	22.992	23.306	24.146	21.916	23.363	23.422	22.098	23.643	24.231	22.458	21.651	22.186	22.194	22.844	23.962
	Hyderaba	21.651	22.644	22.926	22.76	22.706	23.107	23.568	24.188	22.103	23.413	23.625	22.14	23.76	24.253	22.66	21.829	22.26	22.304	23.122	24.129
	Karachi	21.5	22.5	22.8	22.775	22.475	22.975	23.55	24.075	22.075	23.25	23.575	22.025	23.575	24.1	22.675	21.825	22.025	22.25	23.175	24.125
	Larkana	21.042	22.188	22.542	22.396	22.271	22.642	22.758	24.083	21.417	23.117	22.829	21.808	23.092	24.046	21.963	21.054	21.604	21.804	22.179	23.525
	Mirpur Kh	22.173	23.039	23.282	23.07	23.093	23.491	23.784	24.455	22.484	23.818	23.977	22.596	24.282	24.671	22.963	22.257	22.914	22.711	23.393	24.436
Districts	Sukkur	20.89	21.91	22.273	22.085	22.063	22.423	22.629	23.762	21.225	22.892	22.771	21.608	23.01	23.79	21.81	20.975	21.533	21.623	22.115	23.377

APPENDIX 7

NDVI During *Kharif* Season Data (Max, Median and Standard Deviation)

NDVI during Kharif Season	1981			1982			1983			1984			1985			1986			1987		
	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD
Azad Kashmir	0.59	0.4329	0.1551	0.5514	0.3952	0.1768	0.5555	0.4449	0.1535	0.5299	0.3529	0.1835	0.5446	0.4109	0.1795	0.5665	0.4518	0.1667	0.552	0.4444	0.1267
Balochistan	0.0938	0.0799	0.0081	0.0973	0.0841	0.0104	0.1028	0.0841	0.0103	0.0983	0.0806	0.0104	0.097	0.0823	0.0094	0.0985	0.0821	0.0097	0.0949	0.0821	0.0083
Kalat	0.0913	0.0794	0.0072	0.095	0.0824	0.0102	0.1022	0.0846	0.0103	0.0993	0.0806	0.0106	0.0966	0.0827	0.0091	0.0979	0.0809	0.0094	0.0899	0.08	0.0074
Makran	0.0367	0.0314	0.003	0.0361	0.0331	0.0032	0.0379	0.0309	0.0036	0.0369	0.0308	0.0035	0.0358	0.0323	0.0027	0.036	0.0318	0.0027	0.0372	0.0326	0.0025
Nasirabad	0.1537	0.1041	0.0255	0.1501	0.1094	0.0258	0.1738	0.1115	0.0317	0.1728	0.1136	0.0321	0.1666	0.1112	0.0294	0.1757	0.1124	0.0328	0.1537	0.1161	0.0244
Quetta	0.0772	0.0691	0.0055	0.0814	0.0721	0.0077	0.0802	0.0676	0.0065	0.075	0.0663	0.006	0.0787	0.0676	0.0071	0.0753	0.0684	0.0052	0.079	0.0683	0.006
Sibi	0.1466	0.1213	0.0129	0.1495	0.1321	0.0143	0.1559	0.1319	0.013	0.1496	0.1259	0.0122	0.1487	0.1309	0.0122	0.1552	0.1286	0.0141	0.1475	0.1308	0.0119
Zhob	0.1368	0.1186	0.0112	0.1464	0.1267	0.0156	0.1534	0.1287	0.0138	0.1406	0.119	0.0144	0.138	0.1202	0.0121	0.1426	0.1239	0.0135	0.1454	0.1233	0.0129
F.A.T.A	0.299	0.241	0.052	0.289	0.239	0.052	0.3028	0.2509	0.0501	0.2946	0.2352	0.051	0.2831	0.2424	0.0472	0.2889	0.2478	0.0481	0.3026	0.2502	0.0417
F.C.T/ ISLAMABAD	0.505	0.355	0.153	0.527	0.419	0.1333	0.5482	0.4472	0.1622	0.5424	0.4575	0.1152	0.5333	0.4462	0.1043	0.5431	0.4794	0.1278	0.4967	0.4431	0.0552
N.W.F.P./Khyber-Pakhtunwala	0.3736	0.2733	0.0876	0.34	0.2553	0.0859	0.3552	0.2762	0.0846	0.3486	0.2495	0.09	0.3375	0.2587	0.0882	0.3604	0.284	0.0883	0.3455	0.2716	0.0707
Bannu	0.1856	0.1462	0.0255	0.1767	0.1449	0.0235	0.1915	0.1565	0.0242	0.1936	0.1472	0.0268	0.5333	0.14	0.0232	0.1861	0.1514	0.0222	0.1967	0.1549	0.0238
Dera Ismail Khan	0.2218	0.1755	0.0318	0.2071	0.1703	0.0303	0.2429	0.1972	0.0325	0.2186	0.1649	0.0297	0.1763	0.1586	0.0261	0.2241	0.1841	0.0305	0.2117	0.1746	0.0273
Hazara	0.5252	0.3761	0.1409	0.4849	0.3469	0.1428	0.4848	0.3714	0.131	0.4752	0.3265	0.1455	0.1946	0.3602	0.1473	0.5116	0.4006	0.1433	0.4835	0.3792	0.1075
Kohat	0.3234	0.2571	0.0478	0.3009	0.2569	0.0337	0.3225	0.2738	0.038	0.3408	0.264	0.0502	0.4837	0.2439	0.0318	0.3012	0.2645	0.0313	0.307	0.2652	0.0319
Malakand	0.3431	0.2317	0.0879	0.2933	0.208	0.0871	0.3048	0.2221	0.0932	0.2942	0.1961	0.091	0.284	0.2135	0.0916	0.3215	0.2404	0.0926	0.3057	0.2254	0.0779
Mardan	0.5411	0.4169	0.1489	0.5231	0.3916	0.1497	0.546	0.4409	0.1241	0.552	0.4265	0.1525	0.2951	0.4211	0.1545	0.548	0.4236	0.153	0.5023	0.4116	0.1138
Peshawar	0.4177	0.3586	0.0659	0.3999	0.3471	0.0638	0.438	0.3699	0.0659	0.4367	0.3585	0.0652	0.5344	0.3381	0.0655	0.4014	0.3457	0.0729	0.4066	0.3423	0.0472
Northern Areas- Gilgit Baltistan	0.1739	0.1151	0.0387	0.141	0.0937	0.031	0.1652	0.1054	0.0391	0.1653	0.1084	0.0345	0.3966	0.1011	0.0299	0.1669	0.1098	0.0348	0.1634	0.1	0.0389
Punjab	0.331	0.2642	0.0563	0.3304	0.2524	0.0563	0.3638	0.281	0.0586	0.3515	0.2688	0.0666	0.3354	0.2634	0.0611	0.3492	0.2742	0.0599	0.3366	0.263	0.0556
Bahawalpur	0.2389	0.184	0.0479	0.244	0.1821	0.051	0.2859	0.2077	0.0555	0.268	0.189	0.056	0.2498	0.1871	0.047	0.2764	0.206	0.0526	0.2529	0.187	0.0466
Dera Ghazi Khan	0.235	0.1867	0.0364	0.2286	0.1828	0.0349	0.2571	0.1993	0.04	0.2466	0.1826	0.0415	0.2324	0.1812	0.0333	0.2471	0.1925	0.0385	0.2458	0.1874	0.0396
Faisalabad	0.3827	0.3338	0.0469	0.3766	0.2998	0.0476	0.4065	0.3289	0.0511	0.371	0.299	0.0633	0.3766	0.3096	0.059	0.3839	0.3131	0.0598	0.3853	0.319	0.0511
Gujranwala	0.4844	0.3728	0.0898	0.5008	0.3509	0.0973	0.5251	0.396	0.0865	0.5283	0.4025	0.1118	0.5025	0.3836	0.1095	0.5162	0.379	0.0999	0.4847	0.3796	0.0793
Lahore	0.4617	0.3765	0.0778	0.4571	0.3422	0.0754	0.4938	0.3775	0.0737	0.4732	0.3749	0.0922	0.4666	0.3766	0.0871	0.4822	0.381	0.0821	0.4632	0.3705	0.0673
Multan	0.4323	0.3706	0.0735	0.4452	0.3573	0.0785	0.4916	0.3997	0.0822	0.4734	0.3781	0.0947	0.4848	0.3933	0.1045	0.4959	0.4068	0.0978	0.5148	0.3745	0.12
Rawalpindi	0.3833	0.2784	0.0715	0.3837	0.2862	0.0673	0.4132	0.321	0.0688	0.4159	0.3233	0.0782	0.3748	0.2895	0.0688	0.3711	0.3034	0.0551	0.3362	0.2869	0.0436
Sargodha	0.2827	0.2261	0.0436	0.2644	0.2065	0.0365	0.2901	0.2258	0.0407	0.2867	0.2201	0.0453	0.2562	0.2039	0.0375	0.2678	0.2153	0.0371	0.2568	0.2095	0.0324
Sind	0.2834	0.1936	0.0545	0.2682	0.1885	0.0515	0.3067	0.2155	0.059	0.2913	0.2034	0.0559	0.2758	0.1962	0.0496	0.2741	0.1954	0.0488	0.2383	0.19	0.0364
Hyderabad	0.2506	0.1804	0.0421	0.2407	0.1789	0.0404	0.2637	0.1992	0.0414	0.2524	0.1838	0.0399	0.2514	0.1859	0.0394	0.2532	0.1873	0.0392	0.2346	0.1901	0.0311
Karachi	0.1929	0.1487	0.0275	0.1874	0.1422	0.0262	0.2462	0.1648	0.0396	0.232	0.1495	0.0414	0.2071	0.1552	0.0281	0.2073	0.1427	0.0292	0.1577	0.1392	0.018
Larkana	0.4214	0.2855	0.0942	0.4083	0.2873	0.0925	0.4284	0.3145	0.0945	0.4299	0.3173	0.0991	0.4418	0.2916	0.1012	0.4312	0.3083	0.0989	0.4183	0.3177	0.0856
Mirpur Khas	0.3276	0.2003	0.0649	0.2946	0.1847	0.0589	0.3713	0.2307	0.0798	0.3462	0.2091	0.072	0.2884	0.1961	0.0511	0.2785	0.1822	0.0492	0.1931	0.1618	0.0257
Rann of Kutch	0.3157	0.2158	0.0755	0.3052	0.2073	0.0675	0.3201	0.1943	0.0609	0.2769	0.1767	0.0587	0.3234	0.2326	0.0616	0.2773	0.1822	0.0484	0.3096	0.2087	0.0564
Sukkur	0.2255	0.1665	0.0444	0.2204	0.1649	0.0421	0.245	0.1811	0.046	0.2267	0.1773	0.042	0.2255	0.1703	0.0403	0.2324	0.1746	0.0405	0.2174	0.1669	0.0345

		NDVI during Kharif Season																				
YEAR		1988			1989			1990			1991			1992			1993			1994		
		MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD
PROVIN	Azad Kas	0.5912	0.4188	0.1831	0.5933	0.4577	0.1447	0.5925	0.4692	0.1454	0.556	0.4221	0.1606	0.5636	0.422	0.186	0.5584	0.4659	0.1509	0.5689	0.4215	0.1823
PROVIN	Balochis	0.0994	0.08	0.0111	0.1023	0.0847	0.0101	0.0946	0.0816	0.0077	0.0941	0.0825	0.0075	0.1026	0.0872	0.0099	0.0975	0.0841	0.008	0.1155	0.0868	0.0162
	Kalat	0.0966	0.0786	0.0106	0.0987	0.0837	0.0091	0.0917	0.0795	0.0071	0.0884	0.0793	0.0067	0.101	0.0857	0.0102	0.0904	0.0801	0.0066	0.1201	0.0863	0.0184
	Makran	0.0378	0.0302	0.004	0.0378	0.0326	0.0032	0.0366	0.0311	0.0028	0.0364	0.033	0.0023	0.0368	0.0326	0.0032	0.0365	0.0328	0.0022	0.0386	0.0315	0.0047
	Nasirabac	0.1857	0.1149	0.0361	0.1923	0.1182	0.0369	0.1569	0.1137	0.0245	0.1561	0.1105	0.0261	0.1773	0.125	0.0293	0.1762	0.125	0.0271	0.2148	0.1378	0.0458
	Quetta	0.0764	0.0661	0.0069	0.0793	0.0706	0.0059	0.0771	0.0694	0.0054	0.0796	0.0719	0.0045	0.0796	0.0697	0.0058	0.0828	0.0716	0.0057	0.0796	0.067	0.0083
	Sibi	0.1562	0.1279	0.0156	0.1645	0.1325	0.016	0.1484	0.1287	0.0109	0.1453	0.1261	0.0111	0.1613	0.1379	0.0139	0.1538	0.1325	0.012	0.1849	0.1371	0.0231
Districts	Zhob	0.1451	0.1198	0.0147	0.1491	0.1267	0.0134	0.1394	0.1229	0.0105	0.1442	0.1273	0.0112	0.1526	0.1346	0.0125	0.147	0.1286	0.0121	0.1625	0.1305	0.0187
PROVIN	F.A.T.A	0.3072	0.2353	0.0552	0.3045	0.2541	0.0394	0.2916	0.2444	0.0381	0.2995	0.2556	0.0473	0.3049	0.2633	0.0425	0.3057	0.2601	0.0374	0.3255	0.2532	0.0532
PROVIN	F.C.T/ ISL	0.5629	0.4569	0.146	0.5243	0.43	0.1264	0.5631	0.443	0.1462	0.5318	0.4336	0.1435	0.5474	0.4369	0.1409	0.5145	0.4549	0.115	0.5358	0.452	0.1016
PROVIN	N.W.F.P./	0.3813	0.2761	0.0986	0.377	0.291	0.0795	0.3645	0.2858	0.0791	0.3604	0.2842	0.0802	0.3732	0.2929	0.0789	0.3618	0.2977	0.0695	0.3823	0.2888	0.0843
	Bannu	0.2263	0.1521	0.0348	0.5243	0.1535	0.026	0.1836	0.1483	0.0215	0.5318	0.1604	0.0248	0.5474	0.1637	0.0261	0.5145	0.1643	0.0223	0.2342	0.1612	0.0361
	Dera Isma	0.2392	0.1713	0.0379	0.2019	0.1774	0.0339	0.2143	0.1738	0.0276	0.2004	0.182	0.0297	0.2124	0.2026	0.0316	0.2007	0.1924	0.0252	0.284	0.2075	0.0433
	Hazara	0.5237	0.3849	0.1515	0.2354	0.4126	0.1346	0.5158	0.4094	0.1228	0.2204	0.3901	0.1324	0.2585	0.3875	0.1315	0.2266	0.4097	0.1111	0.5136	0.3863	0.1377
	Kohat	0.3461	0.2511	0.0524	0.5386	0.2564	0.0349	0.3142	0.2488	0.0381	0.5045	0.2673	0.0291	0.5083	0.2799	0.0368	0.5018	0.2756	0.031	0.3504	0.2633	0.047
	Malakand	0.3303	0.229	0.0996	0.313	0.2539	0.0716	0.3263	0.2434	0.0775	0.3048	0.2406	0.0816	0.3336	0.2541	0.0789	0.3103	0.2561	0.0771	0.333	0.2464	0.0867
	Mardan	0.5933	0.4394	0.1741	0.3364	0.4326	0.1484	0.554	0.4436	0.1608	0.3201	0.4441	0.1303	0.3271	0.4424	0.1305	0.3266	0.4535	0.1021	0.55	0.4437	0.1063
Districts	Peshawar	0.4532	0.3754	0.0842	0.5599	0.3502	0.0745	0.4144	0.3505	0.0742	0.5471	0.3574	0.0708	0.563	0.3639	0.0507	0.5327	0.3651	0.0376	0.4217	0.3658	0.0396
PROVIN	Northern	0.1713	0.113	0.0401	0.4143	0.115	0.0387	0.1817	0.1218	0.0354	0.4227	0.1122	0.0364	0.4256	0.1003	0.0377	0.4117	0.1239	0.0365	0.1925	0.1243	0.0419
PROVIN	Punjab	0.3865	0.2738	0.079	0.3775	0.2783	0.0691	0.368	0.2759	0.069	0.3755	0.2761	0.0657	0.3956	0.2882	0.0739	0.3689	0.2948	0.0569	0.4204	0.3069	0.0777
	Bahawalp	0.2811	0.1984	0.061	0.301	0.2111	0.0617	0.2824	0.199	0.0605	0.285	0.2018	0.0566	0.335	0.212	0.0759	0.3086	0.2392	0.056	0.3643	0.2492	0.0793
	Dera Gha:	0.2781	0.1915	0.051	0.2778	0.1963	0.048	0.2576	0.1917	0.0436	0.2777	0.1949	0.0459	0.2877	0.2089	0.0487	0.2654	0.2138	0.0376	0.3209	0.2186	0.0627
	Faisalaba	0.4257	0.3125	0.0789	0.4323	0.3363	0.0715	0.4035	0.3256	0.0625	0.4261	0.3158	0.0622	0.4382	0.3462	0.0699	0.3959	0.3394	0.0411	0.4594	0.3527	0.0632
	Gujranwal	0.5772	0.4004	0.1256	0.5382	0.3896	0.1067	0.5453	0.3991	0.1129	0.5284	0.3847	0.1059	0.5421	0.3825	0.1092	0.5406	0.3964	0.0988	0.5732	0.425	0.1078
	Lahore	0.5166	0.3722	0.1052	0.4933	0.3886	0.0852	0.4879	0.3738	0.087	0.4709	0.364	0.0763	0.5054	0.3846	0.0921	0.4869	0.3903	0.0677	0.5297	0.4131	0.0877
	Multan	0.5244	0.4027	0.1151	0.547	0.4081	0.1116	0.5488	0.4205	0.1203	0.5798	0.419	0.1167	0.5557	0.4276	0.1133	0.5004	0.4134	0.087	0.561	0.4423	0.1122
	Rawalpin	0.4481	0.3028	0.0913	0.383	0.2834	0.0655	0.4013	0.2975	0.0702	0.4007	0.3103	0.0642	0.4236	0.3158	0.0744	0.3806	0.314	0.0578	0.4335	0.3153	0.08
Districts	Sargodha	0.3253	0.2214	0.0638	0.2951	0.2208	0.0448	0.283	0.2174	0.0419	0.2894	0.2221	0.0391	0.3094	0.235	0.0432	0.3008	0.2386	0.0378	0.3406	0.2422	0.0512
PROVIN	Sind	0.3076	0.2066	0.0596	0.3035	0.2033	0.0571	0.3026	0.2082	0.0573	0.254	0.1924	0.0387	0.3174	0.2166	0.0597	0.2711	0.2179	0.0414	0.3729	0.2333	0.0859
	Hyderaba	0.2613	0.1888	0.0417	0.2658	0.1915	0.0419	0.2605	0.1932	0.041	0.2368	0.1848	0.0303	0.2675	0.2003	0.0395	0.2397	0.2007	0.0314	0.3078	0.2005	0.0612
	Karachi	0.2076	0.1457	0.0307	0.2137	0.1525	0.0325	0.2115	0.1537	0.0304	0.1695	0.1419	0.0193	0.2625	0.168	0.0448	0.1735	0.1486	0.0225	0.3461	0.1947	0.0798
	Larkana	0.4343	0.3135	0.0977	0.4514	0.3012	0.1075	0.4351	0.3158	0.0966	0.4398	0.3027	0.1034	0.4377	0.3161	0.0971	0.451	0.3458	0.0977	0.4613	0.3119	0.1066
	Mirpur Kh	0.38	0.2139	0.0814	0.344	0.2025	0.067	0.3666	0.2141	0.078	0.2306	0.1848	0.0257	0.3965	0.2332	0.085	0.2727	0.2195	0.0375	0.5028	0.2751	0.1365
	Rann of K	0.3288	0.1752	0.0833	0.4204	0.1972	0.1161	0.3749	0.2398	0.0831	0.3154	0.1898	0.0859	0.3445	0.2182	0.0696	0.375	0.2524	0.1073	0.3939	0.2177	0.102
Districts	Sukkur	0.2435	0.1805	0.0456	0.251	0.1807	0.0459	0.2378	0.1781	0.0414	0.2257	0.1656	0.0362	0.2491	0.1799	0.0437	0.2384	0.1877	0.0349	0.2816	0.2001	0.0551

NDVI During *Kharif* Season Data (Max, Median and Standard Deviation) continued

YEAR		1995			1996			1997			1998			1999			2000			2001			2002		
		MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD
PROVINCE	Azad Kas	0.5819	0.4622	0.1371	0.5821	0.4767	0.1245	0.6078	0.474	0.1489	0.5655	0.4678	0.1208	0.5727	0.4306	0.1741	0.5422	0.3895	0.1838	0.6049	0.4638	0.1619	0.5871	0.4562	0.098
PROVINCE	Balochis	0.1019	0.0865	0.0097	0.0956	0.0832	0.0078	0.0989	0.0855	0.0093	0.0985	0.0851	0.009	0.0961	0.0825	0.0082	0.0914	0.0779	0.0085	0.1111	0.0876	0.0148	0.1035	0.084	0.013
	Kalat	0.1014	0.0862	0.0095	0.0921	0.0813	0.0066	0.0954	0.084	0.0075	0.0949	0.083	0.0083	0.0898	0.0794	0.0064	0.0864	0.0749	0.0076	0.1073	0.0882	0.0134	0.0987	0.0819	0.0121
	Makran	0.0355	0.0313	0.0027	0.0374	0.032	0.0026	0.0367	0.0322	0.0026	0.0395	0.033	0.0031	0.0374	0.0323	0.0026	0.0367	0.0318	0.003	0.0743	0.0469	0.0169	0.0679	0.0451	0.0131
	Nasirabad	0.1846	0.1329	0.0319	0.1736	0.1258	0.031	0.1785	0.1294	0.0345	0.1817	0.1327	0.0339	0.1884	0.1321	0.0369	0.1781	0.123	0.0346	0.2204	0.1291	0.0553	0.1963	0.1182	0.0474
	Quetta	0.0766	0.0673	0.0058	0.0801	0.0711	0.0053	0.0788	0.0697	0.0051	0.0809	0.0702	0.0064	0.0807	0.0701	0.0054	0.0768	0.0661	0.0054	0.0815	0.0709	0.0068	0.0804	0.0701	0.0062
	Sibi	0.1589	0.1376	0.0142	0.1456	0.1288	0.0108	0.1508	0.1311	0.0148	0.1456	0.1317	0.0102	0.1477	0.128	0.012	0.1386	0.1218	0.0108	0.156	0.126	0.0152	0.1375	0.1232	0.0137
Districts	Zhob	0.1503	0.13	0.0128	0.1358	0.1219	0.0104	0.1488	0.1298	0.0155	0.1432	0.1267	0.0115	0.1394	0.1218	0.0112	0.1296	0.1136	0.0109	0.1388	0.1182	0.0126	0.1362	0.1185	0.0122
PROVINCE	F.A.T.A	0.3199	0.2622	0.0464	0.2963	0.2537	0.0397	0.3027	0.2531	0.0538	0.3141	0.269	0.0416	0.297	0.2397	0.0514	0.2713	0.2165	0.0498	0.2936	0.2404	0.0477	0.286	0.231	0.046
PROVINCE	F.C.T/ ISL	0.5547	0.4645	0.0808	0.5577	0.476	0.0766	0.568	0.4402	0.0898	0.5775	0.4935	0.1209	0.5535	0.3931	0.1722	0.5337	0.4431	0.1524	0.564	0.4783	0.1311	0.5695	0.4151	0.1034
PROVINCE	N.W.F.P./	0.3768	0.2987	0.0779	0.3665	0.2991	0.0679	0.3802	0.2959	0.0784	0.3722	0.3052	0.0669	0.3666	0.2762	0.0888	0.3423	0.2509	0.0941	0.3709	0.2824	0.0884	0.3602	0.2741	0.0726
	Bannu	0.2117	0.1614	0.0301	0.1923	0.1552	0.0237	0.568	0.1562	0.0236	0.2104	0.1668	0.0275	0.2051	0.1534	0.0289	0.5337	0.1359	0.0252	0.564	0.1481	0.0374	0.5695	0.4151	0.0352
	Dera Isma	0.253	0.2014	0.035	0.2285	0.1896	0.0295	0.1907	0.1962	0.0316	0.2337	0.1889	0.0313	0.2343	0.1809	0.0322	0.1831	0.1666	0.0331	0.2051	0.1651	0.0379	0.1857	0.126	0.0347
	Hazara	0.5153	0.4089	0.1202	0.5162	0.4148	0.1084	0.2343	0.4078	0.1212	0.5073	0.4196	0.1078	0.501	0.3792	0.1383	0.2214	0.3533	0.1475	0.2227	0.4016	0.1294	0.2034	0.1526	0.1097
	Kohat	0.3437	0.2713	0.0452	0.3114	0.2686	0.0299	0.5323	0.2657	0.0366	0.3497	0.2895	0.0387	0.3225	0.2566	0.0439	0.4722	0.2347	0.0405	0.522	0.256	0.038	0.521	0.4038	0.0375
	Malakand	0.3297	0.2539	0.078	0.3267	0.2614	0.0693	0.313	0.253	0.0891	0.327	0.2585	0.0648	0.3277	0.2331	0.0905	0.2932	0.1994	0.0949	0.3101	0.2423	0.0893	0.3052	0.2344	0.0676
	Mardan	0.564	0.4681	0.1209	0.5422	0.4539	0.1074	0.3479	0.4629	0.1045	0.5639	0.4827	0.1084	0.5571	0.4267	0.1528	0.3012	0.4179	0.178	0.3342	0.4436	0.1703	0.319	0.2414	0.1413
Districts	Peshawar	0.4364	0.3709	0.0689	0.4263	0.3632	0.0517	0.5674	0.3656	0.0493	0.4415	0.3899	0.0465	0.4251	0.3604	0.0816	0.5382	0.3292	0.0867	0.557	0.3429	0.088	0.5535	0.3935	0.0675
PROVINCE	Northern	0.1731	0.1125	0.0368	0.1736	0.118	0.0393	0.426	0.1125	0.0391	0.1795	0.1169	0.037	0.1788	0.121	0.0335	0.4037	0.1051	0.0338	0.4239	0.1113	0.0404	0.4105	0.3389	0.034
PROVINCE	Punjab	0.3918	0.2951	0.0685	0.38	0.2943	0.066	0.3883	0.3051	0.0676	0.3877	0.3023	0.0632	0.3676	0.2805	0.0666	0.3544	0.27	0.0688	0.3847	0.2918	0.0781	0.3583	0.25	0.0693
	Bahawalp	0.3212	0.228	0.0643	0.2917	0.219	0.0564	0.2986	0.2269	0.0619	0.3045	0.2258	0.0548	0.2828	0.2064	0.0517	0.2768	0.2094	0.0556	0.3123	0.2283	0.0682	0.2451	0.1618	0.0564
	Dera Gha	0.2955	0.2151	0.0501	0.2729	0.214	0.0449	0.2774	0.2148	0.0475	0.2779	0.2124	0.044	0.2668	0.2046	0.0419	0.2573	0.1973	0.0446	0.2927	0.2159	0.0587	0.2624	0.184	0.051
	Faisalaba	0.4099	0.3443	0.0519	0.4288	0.3557	0.06	0.4515	0.3838	0.0621	0.4185	0.3515	0.0522	0.3981	0.3278	0.0627	0.3896	0.3168	0.0615	0.4148	0.344	0.0594	0.3982	0.3008	0.054
	Gujranwal	0.5448	0.3982	0.102	0.5652	0.4183	0.1044	0.5745	0.4266	0.1074	0.5704	0.428	0.1045	0.5566	0.4142	0.1224	0.5163	0.3679	0.1187	0.5324	0.401	0.1437	0.5739	0.3875	0.1354
	Lahore	0.5041	0.3913	0.082	0.517	0.4003	0.0818	0.5288	0.4198	0.0839	0.5142	0.407	0.0794	0.5021	0.3772	0.1008	0.4797	0.3605	0.0979	0.4993	0.3808	0.0966	0.4891	0.3527	0.0847
	Multan	0.547	0.4305	0.1062	0.5209	0.4061	0.12	0.5375	0.4434	0.1069	0.5396	0.4293	0.0956	0.4907	0.3858	0.0873	0.4984	0.3979	0.1015	0.5233	0.4185	0.1009	0.4889	0.362	0.0907
	Rawalpin	0.4316	0.3207	0.0751	0.4122	0.3201	0.0611	0.4176	0.3213	0.0662	0.4303	0.3452	0.0697	0.403	0.3037	0.0742	0.3765	0.2819	0.0745	0.4114	0.3189	0.0835	0.4111	0.2703	0.0785
Districts	Sargodha	0.3093	0.2327	0.0473	0.3034	0.2374	0.0423	0.3034	0.2388	0.043	0.3095	0.2425	0.0433	0.2995	0.231	0.0497	0.2835	0.2129	0.0486	0.3172	0.2215	0.0573	0.2873	0.1977	0.0492
PROVINCE	Sind	0.2952	0.2145	0.0495	0.2757	0.2097	0.0441	0.2949	0.2185	0.0506	0.2837	0.2192	0.0457	0.2725	0.2128	0.0422	0.2578	0.1888	0.0459	0.3061	0.2072	0.0647	0.2443	0.1674	0.0531
	Hyderaba	0.2676	0.2	0.0391	0.2474	0.1934	0.0322	0.2561	0.1996	0.0349	0.2524	0.2048	0.0335	0.2438	0.1905	0.0346	0.2256	0.1718	0.0361	0.2733	0.1834	0.0487	0.24	0.1739	0.044
	Karachi	0.2274	0.1693	0.0318	0.179	0.1512	0.019	0.1911	0.1521	0.0231	0.1705	0.1469	0.0186	0.1591	0.1378	0.0142	0.1617	0.1331	0.0183	0.1902	0.1339	0.0351	0.1578	0.126	0.0298
	Larkana	0.4693	0.3188	0.1058	0.4494	0.3199	0.1059	0.4367	0.3127	0.1012	0.4536	0.3494	0.0988	0.4534	0.3355	0.0976	0.4147	0.2853	0.0983	0.4916	0.3114	0.1219	0.4531	0.2883	0.1156
	Mirpur Kh	0.3008	0.2186	0.0456	0.2796	0.2156	0.0398	0.3371	0.2337	0.0585	0.2941	0.2158	0.0436	0.2655	0.2194	0.0325	0.2778	0.1924	0.0459	0.301	0.2125	0.067	0.1799	0.1256	0.0403
	Rann of K	0.303	0.2002	0.0528	0.417	0.2388	0.0996	0.3829	0.2717	0.0821	0.2972	0.2228	0.0544	0.3207	0.2356	0.0491	0.3368	0.2097	0.0714	0.3594	0.2489	0.1084	0.3079	0.1973	0.0937
Districts	Sukkur	0.2533	0.1867	0.0439	0.2389	0.1807	0.0388	0.2465	0.1906	0.0426	0.2486	0.1902	0.0428	0.2474	0.187	0.0403	0.217	0.169	0.0376	0.2826	0.1931	0.0603	0.2327	0.1527	0.0529

2003			2004			2005			2006			2007			2008			2009			2010		
MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD
0.567	0.4532	0.1146	0.5829	0.4781	0.0993	0.5837	0.4669	0.1236	0.5898	0.4853	0.1268	0.6111	0.5085	0.0984	0.5808	0.487	0.1411	0.6071	0.4453	0.1568	0.6012	0.425	0.1938
0.1125	0.0865	0.0159	0.0889	0.0634	0.0169	0.0941	0.0699	0.0176	0.107	0.0794	0.0201	0.1194	0.0876	0.023	0.1043	0.0774	0.0192	0.1092	0.0874	0.0148	0.1203	0.0894	0.0178
0.1117	0.0872	0.0154	0.0835	0.0596	0.016	0.0875	0.0645	0.0172	0.1049	0.0794	0.0198	0.1259	0.0936	0.0261	0.1045	0.078	0.0191	0.1024	0.0856	0.0127	0.1145	0.0881	0.016
0.0694	0.041	0.0165	0.035	0.0199	0.0098	0.0357	0.0216	0.0118	0.0357	0.0222	0.0112	0.0472	0.0238	0.0144	0.0359	0.0178	0.0128	0.0393	0.0337	0.0071	0.0455	0.036	0.006
0.2322	0.1379	0.0565	0.1828	0.0814	0.0588	0.1971	0.0956	0.0634	0.2179	0.121	0.0562	0.2585	0.1163	0.0868	0.2137	0.1159	0.0607	0.2226	0.1044	0.0616	0.2304	0.1153	0.0672
0.08	0.0674	0.0075	0.0699	0.0549	0.011	0.0706	0.056	0.0106	0.0745	0.0581	0.0146	0.0779	0.0634	0.0107	0.0676	0.0551	0.0106	0.083	0.0724	0.0083	0.0804	0.0719	0.0066
0.1541	0.1287	0.0152	0.1384	0.098	0.0266	0.1457	0.1155	0.023	0.1758	0.129	0.0305	0.1708	0.1348	0.0258	0.1655	0.1286	0.0281	0.1773	0.1429	0.0239	0.2112	0.1478	0.0338
0.1409	0.1194	0.0133	0.1292	0.1091	0.0149	0.1453	0.1245	0.0155	0.1588	0.13	0.0198	0.1592	0.1381	0.0159	0.1565	0.1305	0.0181	0.1638	0.1362	0.0165	0.1843	0.1345	0.0243
0.2963	0.2469	0.0444	0.2793	0.2244	0.0431	0.3009	0.253	0.0425	0.3263	0.2604	0.0564	0.3252	0.276	0.0518	0.3172	0.2607	0.0512	0.3243	0.2637	0.0467	0.3798	0.2584	0.0816
0.5619	0.4793	0.1167	0.5263	0.4397	0.071	0.5647	0.4649	0.0983	0.5647	0.4728	0.138	0.5637	0.497	0.0689	0.5531	0.4745	0.1506	0.5783	0.4043	0.1131	0.5652	0.4017	0.1091
0.3619	0.2838	0.0709	0.3591	0.2824	0.0679	0.3697	0.2893	0.0761	0.3764	0.2988	0.0874	0.3857	0.3118	0.0677	0.3738	0.3008	0.083	0.3846	0.2879	0.0812	0.4097	0.2856	0.107
0.5619	0.1655	0.0325	0.5263	0.1025	0.0528	0.2021	0.1194	0.0456	0.2056	0.1471	0.0348	0.5637	0.1219	0.0451	0.5531	0.147	0.0341	0.2032	0.1402	0.0452	0.5652	0.139	0.07
0.2139	0.1787	0.039	0.1953	0.1271	0.0476	0.2354	0.1536	0.0501	0.2356	0.1742	0.0407	0.2096	0.1725	0.0498	0.2082	0.1825	0.049	0.2656	0.1931	0.0511	0.2855	0.1701	0.0709
0.2338	0.3832	0.1097	0.2097	0.4243	0.0947	0.5095	0.4108	0.1101	0.5135	0.4217	0.1233	0.249	0.4406	0.0919	0.2504	0.4186	0.1233	0.5219	0.3936	0.1241	0.3193	0.394	0.1565
0.4982	0.2709	0.0323	0.5175	0.2391	0.0397	0.3177	0.2678	0.0483	0.3463	0.2611	0.0611	0.5327	0.2965	0.0346	0.5094	0.2791	0.0448	0.3417	0.2675	0.0406	0.534	0.2554	0.0826
0.3165	0.2342	0.0717	0.2877	0.2509	0.067	0.3357	0.2556	0.0627	0.3335	0.2609	0.0878	0.3361	0.2722	0.0653	0.3414	0.2567	0.072	0.3356	0.2486	0.0754	0.4139	0.2505	0.099
0.3121	0.4756	0.1037	0.3214	0.4626	0.0938	0.5462	0.46	0.1521	0.57	0.4668	0.1616	0.3435	0.4998	0.105	0.3254	0.4875	0.1694	0.5983	0.4349	0.1341	0.3396	0.4464	0.1323
0.5637	0.3816	0.0568	0.5498	0.3508	0.0495	0.4192	0.3666	0.0803	0.4297	0.3682	0.0621	0.5762	0.3873	0.0637	0.5713	0.3715	0.0914	0.4516	0.3664	0.0675	0.5912	0.3646	0.0879
0.4466	0.1019	0.0392	0.4104	0.1102	0.04	0.174	0.1136	0.0401	0.1698	0.1162	0.0357	0.4354	0.1209	0.0381	0.4376	0.1161	0.0348	0.1859	0.106	0.0465	0.4622	0.1085	0.0459
0.3848	0.3002	0.0707	0.3605	0.2617	0.0802	0.3779	0.2694	0.0895	0.384	0.28	0.0818	0.3857	0.293	0.0784	0.3884	0.28	0.0898	0.3941	0.2821	0.0703	0.4237	0.2827	0.0885
0.305	0.2244	0.0668	0.2504	0.1544	0.0707	0.2774	0.1656	0.0804	0.2885	0.1867	0.0726	0.295	0.1898	0.0811	0.2861	0.1795	0.0735	0.276	0.1902	0.0561	0.3304	0.2111	0.0795
0.2817	0.2103	0.0527	0.2698	0.1815	0.0668	0.2657	0.1812	0.0632	0.2873	0.205	0.0575	0.2881	0.2004	0.0627	0.2892	0.2024	0.0621	0.3131	0.2225	0.0581	0.3206	0.2112	0.0653
0.4152	0.3386	0.0573	0.4273	0.3412	0.0681	0.4311	0.3277	0.0752	0.4251	0.3364	0.0673	0.4239	0.3565	0.0534	0.4413	0.3374	0.0851	0.4683	0.3586	0.0662	0.4769	0.3492	0.081
0.5727	0.4607	0.1198	0.5529	0.4037	0.1343	0.5824	0.4142	0.1564	0.5615	0.3994	0.1412	0.5723	0.4323	0.1244	0.5824	0.4118	0.1707	0.6096	0.4046	0.1324	0.6129	0.3847	0.1449
0.4983	0.4051	0.0891	0.4931	0.3779	0.1118	0.5203	0.3884	0.1165	0.5169	0.39	0.1073	0.5067	0.3959	0.1077	0.5294	0.381	0.14	0.5571	0.4035	0.0988	0.5534	0.3869	0.1095
0.5334	0.4299	0.1008	0.53	0.4039	0.1204	0.5528	0.4079	0.1375	0.5314	0.413	0.1107	0.5262	0.4257	0.1126	0.5158	0.39	0.0987	0.5334	0.4042	0.0872	0.5458	0.4235	0.1013
0.4167	0.3321	0.065	0.3689	0.2931	0.0552	0.396	0.312	0.0769	0.4296	0.3198	0.0845	0.4252	0.3613	0.0626	0.4225	0.3393	0.0955	0.3864	0.2747	0.0639	0.4589	0.2745	0.1025
0.3076	0.2304	0.0495	0.2784	0.1976	0.0567	0.2943	0.2158	0.0636	0.3006	0.2198	0.0615	0.3094	0.238	0.0507	0.3219	0.2344	0.0647	0.3108	0.2228	0.0477	0.3616	0.2238	0.07
0.2993	0.2199	0.0654	0.2461	0.1365	0.0651	0.2626	0.1488	0.0732	0.3172	0.2055	0.0745	0.3127	0.1987	0.0861	0.2843	0.1947	0.0751	0.3275	0.1998	0.0767	0.3488	0.2052	0.0836
0.2605	0.1957	0.0443	0.2327	0.1297	0.0593	0.2445	0.1472	0.0632	0.2959	0.1881	0.0621	0.2964	0.2025	0.0696	0.2724	0.1852	0.0751	0.3083	0.1948	0.0678	0.3112	0.1979	0.0671
0.2046	0.1444	0.0382	0.1311	0.0368	0.0447	0.1378	0.034	0.0434	0.2612	0.1513	0.0606	0.2785	0.1594	0.0876	0.2107	0.1425	0.0509	0.2619	0.1584	0.0654	0.3019	0.1976	0.0587
0.4342	0.3103	0.1069	0.4718	0.2593	0.1509	0.475	0.284	0.1626	0.4948	0.3167	0.1477	0.4627	0.3018	0.1636	0.4708	0.303	0.1534	0.4911	0.2951	0.1271	0.3936	0.2406	0.1078
0.3184	0.2291	0.0816	0.1895	0.0919	0.0491	0.2403	0.0993	0.0693	0.3288	0.212	0.0733	0.3224	0.1789	0.0979	0.2678	0.1918	0.0607	0.3532	0.1924	0.0918	0.4266	0.2161	0.1126
0.3403	0.2655	0.0751	0.301	0.2018	0.0863	0.307	0.166	0.0809	0.4033	0.1986	0.0943	0.3537	0.2527	0.0833	0.299	0.169	0.1031	0.3392	0.2069	0.0846	0.3712	0.2753	0.076
0.2786	0.2085	0.0602	0.2337	0.1477	0.0526	0.2265	0.1548	0.0528	0.2566	0.1767	0.0601	0.2582	0.1713	0.0597	0.2403	0.1665	0.0569	0.2569	0.175	0.0503	0.2993	0.1871	0.0659

YEAR		2011			2012			2013			2014			2015		
		MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD
PROVIN	Azad Kashmir	0.5733	0.4553	0.1667	0.6033	0.453	0.164	0.5902	0.4898	0.1873	0.6034	0.4708	0.1358	0.6127	0.4647	0.141
PROVIN	Balochistan	0.1232	0.0851	0.0201	0.1203	0.0991	0.0112	0.1211	0.1015	0.0112	0.1138	0.1001	0.0093	0.1159	0.0991	0.0109
	Kalat	0.1248	0.0822	0.0211	0.1139	0.0961	0.0091	0.1159	0.0992	0.0099	0.1096	0.0977	0.0079	0.1073	0.0952	0.0084
	Makran	0.0387	0.0298	0.0084	0.0785	0.0693	0.0064	0.0787	0.0696	0.0069	0.0785	0.0702	0.0079	0.0784	0.0686	0.0101
	Nasirabad	0.2822	0.1167	0.0782	0.238	0.1376	0.0529	0.2461	0.146	0.0531	0.2162	0.1499	0.0407	0.2331	0.1445	0.0497
	Quetta	0.0763	0.0634	0.0092	0.0789	0.0737	0.0031	0.0819	0.0748	0.004	0.0802	0.0745	0.0035	0.0774	0.0719	0.0037
	Sibi	0.204	0.1454	0.0285	0.1854	0.1458	0.0195	0.1723	0.148	0.0143	0.1559	0.1403	0.0109	0.1678	0.1459	0.0134
Districts	Zhob	0.1745	0.1394	0.0194	0.1619	0.1352	0.0136	0.1627	0.138	0.0131	0.1504	0.1345	0.0104	0.1636	0.1385	0.0135
PROVIN	F.A.T.A	0.3454	0.2724	0.061	0.3509	0.2804	0.0536	0.3576	0.2912	0.0623	0.3304	0.2857	0.044	0.3593	0.2924	0.0521
PROVIN	F.C.T/ ISLAMABAD	0.5707	0.4668	0.1137	0.5683	0.4359	0.1168	0.5529	0.483	0.1312	0.5797	0.4575	0.109	0.614	0.4789	0.1012
PROVIN	N.W.F.P./Khyber-Pakhtunwala	0.3861	0.2908	0.0916	0.3904	0.3004	0.0787	0.3929	0.3173	0.0927	0.3846	0.305	0.0791	0.4025	0.3027	0.0779
	Bannu	0.5707	0.1647	0.0668	0.5683	0.1806	0.0368	0.5529	0.1909	0.034	0.2317	0.1776	0.0286	0.2742	0.1916	0.0423
	Dera Ismail Khan	0.2671	0.1842	0.0536	0.252	0.2204	0.035	0.2519	0.2098	0.0297	0.2577	0.2185	0.0284	0.2808	0.2228	0.035
	Hazara	0.2779	0.3889	0.1421	0.27	0.3997	0.1159	0.2518	0.4361	0.147	0.5299	0.4088	0.1385	0.5315	0.3937	0.1271
	Kohat	0.5054	0.2991	0.0606	0.521	0.2715	0.0405	0.5286	0.3014	0.0521	0.3434	0.2892	0.0337	0.4365	0.3169	0.0678
	Malakand	0.3967	0.2409	0.0779	0.3489	0.2523	0.0841	0.3805	0.267	0.0939	0.3315	0.2562	0.0807	0.3283	0.24	0.0723
	Mardan	0.3192	0.4629	0.142	0.3374	0.48	0.1103	0.3368	0.4849	0.1511	0.6036	0.474	0.1132	0.6146	0.4923	0.0871
Districts	Peshawar	0.5783	0.3796	0.0843	0.6042	0.3666	0.0665	0.6087	0.3738	0.0816	0.4203	0.3691	0.0462	0.4778	0.3961	0.0633
PROVIN	Northern Areas- Gilgit Baltistan	0.4652	0.1091	0.0397	0.4417	0.1029	0.0376	0.448	0.1269	0.0363	0.1699	0.112	0.0379	0.1782	0.1074	0.0453
PROVIN	Punjab	0.4473	0.3157	0.0959	0.4456	0.3115	0.0874	0.3995	0.3099	0.0662	0.4066	0.3223	0.0658	0.42	0.3266	0.0672
	Bahawalpur	0.361	0.2254	0.0902	0.3517	0.239	0.073	0.31	0.247	0.051	0.3107	0.2513	0.0506	0.3381	0.2636	0.0598
	Dera Ghazi Khan	0.3572	0.2329	0.0798	0.3564	0.2401	0.0699	0.3132	0.2462	0.0481	0.3068	0.2502	0.0463	0.3336	0.2585	0.0531
	Faisalabad	0.4858	0.3839	0.0867	0.4964	0.3694	0.0777	0.4197	0.3451	0.046	0.4388	0.3636	0.059	0.4464	0.3616	0.0543
	Gujranwala	0.6277	0.4372	0.1348	0.6144	0.4211	0.142	0.557	0.3968	0.1235	0.5866	0.4406	0.1196	0.582	0.4336	0.1107
	Lahore	0.5675	0.4146	0.1064	0.5673	0.405	0.1101	0.5058	0.3879	0.086	0.5276	0.4094	0.0917	0.527	0.4006	0.0902
	Multan	0.5925	0.4661	0.1326	0.6122	0.4392	0.126	0.5358	0.4148	0.0923	0.5437	0.4475	0.0919	0.5275	0.4331	0.0791
	Rawalpindi	0.4625	0.34	0.0902	0.4567	0.3071	0.089	0.4458	0.3419	0.0768	0.4524	0.3408	0.0666	0.4761	0.3584	0.0742
Districts	Sargodha	0.3734	0.2588	0.0783	0.3676	0.2688	0.0605	0.3429	0.2675	0.0512	0.3484	0.2703	0.0507	0.3583	0.279	0.0509
PROVIN	Sind	0.3536	0.194	0.0865	0.3241	0.201	0.0698	0.3113	0.2285	0.0574	0.2887	0.2209	0.0493	0.2935	0.2159	0.0538
	Hyderabad	0.308	0.1948	0.0631	0.3006	0.1905	0.0594	0.2931	0.2135	0.0489	0.2797	0.212	0.0453	0.2766	0.2035	0.0457
	Karachi	0.3033	0.1618	0.0687	0.1989	0.1456	0.0251	0.1992	0.1523	0.0242	0.1658	0.1438	0.0136	0.173	0.1382	0.018
	Larkana	0.4713	0.2768	0.1279	0.4661	0.2628	0.1282	0.4666	0.2953	0.1229	0.4497	0.3206	0.1167	0.4571	0.2862	0.1293
	Mirpur Khas	0.3771	0.1657	0.1024	0.3271	0.1884	0.0696	0.3026	0.2294	0.0542	0.2552	0.1942	0.0358	0.2706	0.1986	0.0445
	Rann of Kutch	0.399	0.289	0.0996	0.3578	0.2552	0.074	0.3626	0.2642	0.069	0.3472	0.2803	0.0581	0.3208	0.2729	0.0369
Districts	Sukkur	0.3406	0.1882	0.0838	0.3001	0.2061	0.0617	0.2854	0.225	0.0456	0.2758	0.2236	0.0421	0.2786	0.2269	0.0442

APPENDIX 8

NDVI During *Rabi* Season Data (Max, Median and Standard Deviation)

		NDVI DURING RABI SEASON																				
YEAR		1982			1983			1984			1985			1986			1987			1988		
		MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD
PROVINCE	Azad Kashmir	0.3416	0.2195	0.0946	0.2974	0.208	0.0889	0.2984	0.1872	0.087	0.3134	0.2016	0.0867	0.3208	0.2453	0.0709	0.3451	0.2437	0.0834	0.3154	0.2229	0.0703
PROVINCE	Balochistan	0.087	0.0772	0.0064	0.0873	0.0761	0.0068	0.0868	0.0785	0.0067	0.0858	0.0772	0.0083	0.0878	0.0796	0.0055	0.0894	0.078	0.0069	0.0853	0.0771	0.0055
	Kalat	0.0848	0.0772	0.005	0.0858	0.0754	0.0062	0.0858	0.0789	0.0053	0.0852	0.0787	0.0063	0.0863	0.0797	0.0041	0.0862	0.0783	0.0049	0.0823	0.0755	0.0042
	Makran	0.0383	0.0345	0.0022	0.037	0.0338	0.0022	0.0376	0.0349	0.002	0.0369	0.0348	0.0033	0.0378	0.0352	0.0016	0.0379	0.0352	0.0016	0.0383	0.0354	0.0019
	Nasirabad	0.1498	0.1156	0.0266	0.1439	0.1082	0.0242	0.1526	0.1262	0.0268	0.1468	0.1167	0.0251	0.1616	0.1258	0.0269	0.1605	0.1187	0.0292	0.1542	0.118	0.0278
	Quetta	0.0769	0.067	0.0056	0.0763	0.0667	0.0058	0.0748	0.0662	0.0062	0.0731	0.0656	0.0109	0.0746	0.0676	0.0045	0.0768	0.0671	0.0056	0.0734	0.0678	0.0038
	Sibi	0.129	0.1154	0.0079	0.126	0.1152	0.0067	0.1287	0.1175	0.0081	0.1266	0.1126	0.0096	0.1292	0.12	0.0066	0.131	0.1163	0.0093	0.127	0.1164	0.0071
Districts	Zhob	0.116	0.1039	0.0078	0.1212	0.1052	0.0091	0.1144	0.1041	0.0088	0.1152	0.1022	0.0094	0.1163	0.1062	0.0068	0.1254	0.1041	0.0108	0.1144	0.1046	0.0065
PROVINCE	F.A.T.A	0.243	0.192	0.0357	0.2411	0.1917	0.0402	0.2347	0.1854	0.0379	0.2362	0.1942	0.032	0.2479	0.2107	0.0326	0.2604	0.203	0.04	0.2507	0.2049	0.0412
PROVINCE	F.C.T/ ISLAMABAD	0.416	0.33	0.0923	0.4575	0.3768	0.1152	0.4334	0.2986	0.0997	0.4055	0.326	0.0454	0.4535	0.4138	0.0479	0.4677	0.39	0.0679	0.4029	0.3222	0.0655
PROVINCE	N.W.F.P./Khyber-Pakhtunwala	0.2642	0.1804	0.0564	0.2452	0.1794	0.0607	0.2448	0.1631	0.0544	0.2419	0.1742	0.0515	0.2498	0.1992	0.0453	0.2613	0.1901	0.0519	0.2597	0.1864	0.0545
	Bannu	0.2342	0.184	0.0415	0.2298	0.1739	0.0449	0.1874	0.1379	0.0361	0.2221	0.1711	0.0449	0.2415	0.1931	0.0393	0.2267	0.182	0.04	0.2121	0.1527	0.0442
	Dera Ismail Khan	0.2171	0.1666	0.0396	0.2053	0.1576	0.0372	0.1976	0.1558	0.0362	0.2113	0.1683	0.0408	0.2209	0.1758	0.0415	0.2144	0.1669	0.0379	0.2019	0.1502	0.038
	Hazara	0.2995	0.1776	0.0755	0.2562	0.1834	0.069	0.2754	0.1689	0.0677	0.2622	0.1704	0.0638	0.2609	0.1972	0.054	0.2896	0.198	0.0669	0.2939	0.1934	0.0599
	Kohat	0.2736	0.2347	0.0274	0.2821	0.2332	0.0384	0.2469	0.2085	0.0306	0.2536	0.2229	0.0241	0.2861	0.2395	0.0308	0.2818	0.2347	0.0291	0.2732	0.2249	0.0335
	Malakand	0.199	0.1166	0.049	0.173	0.1103	0.0481	0.1844	0.107	0.0482	0.1797	0.1145	0.0423	0.1727	0.1283	0.0361	0.1902	0.1251	0.0405	0.1971	0.1283	0.0464
	Mardan	0.4797	0.36	0.107	0.4973	0.3906	0.1489	0.4768	0.3241	0.1117	0.4548	0.355	0.1035	0.4969	0.4378	0.0932	0.5031	0.3728	0.1196	0.4801	0.3896	0.1159
Districts	Peshawar	0.4322	0.3348	0.0826	0.4342	0.3283	0.1233	0.4187	0.2832	0.0841	0.3976	0.3004	0.089	0.4446	0.3872	0.0653	0.4489	0.3572	0.0786	0.443	0.3571	0.1082
PROVINCE	Northern Areas- Gilgit Baltistan	0.0561	0.0295	0.0118	0.0358	0.0238	0.0056	0.061	0.0291	0.0133	0.0447	0.0272	0.0093	0.0391	0.0268	0.0061	0.0448	0.027	0.0079	0.0581	0.0311	0.0119
PROVINCE	Punjab	0.3841	0.278	0.0933	0.3821	0.2711	0.0945	0.3467	0.2428	0.0953	0.3472	0.2521	0.0846	0.4038	0.3162	0.103	0.3869	0.2803	0.1041	0.3723	0.2621	0.0993
	Bahawalpur	0.2562	0.1871	0.054	0.2449	0.1818	0.0482	0.2541	0.1945	0.0501	0.246	0.1952	0.0466	0.28	0.2207	0.0604	0.2817	0.2055	0.0641	0.2702	0.1955	0.061
	Dera Ghazi Khan	0.2555	0.19	0.0531	0.241	0.1792	0.0486	0.24	0.1774	0.0528	0.2432	0.1879	0.0473	0.2665	0.2115	0.0572	0.2627	0.1931	0.0589	0.2599	0.1948	0.0604
	Faisalabad	0.5366	0.4229	0.1299	0.5213	0.3638	0.1402	0.4665	0.3084	0.1668	0.4638	0.3028	0.1536	0.542	0.428	0.1715	0.5097	0.3528	0.1696	0.5189	0.3312	0.1689
	Gujranwala	0.5721	0.3802	0.1716	0.5978	0.4086	0.1695	0.4802	0.3035	0.147	0.476	0.3317	0.1247	0.5999	0.496	0.1536	0.5558	0.415	0.1622	0.5227	0.3642	0.1468
	Lahore	0.5831	0.3897	0.176	0.6046	0.4192	0.1697	0.5216	0.3505	0.1894	0.5236	0.375	0.1553	0.6091	0.4671	0.2014	0.5682	0.412	0.1772	0.5578	0.4032	0.1791
	Multan	0.547	0.367	0.1608	0.5336	0.3614	0.1472	0.4992	0.3321	0.1638	0.5147	0.3295	0.1533	0.5772	0.4031	0.1852	0.5664	0.3482	0.1905	0.5351	0.3178	0.1692
	Rawalpindi	0.3298	0.2636	0.0486	0.3533	0.2733	0.0737	0.3014	0.2319	0.0511	0.2937	0.2498	0.0353	0.3526	0.2967	0.0442	0.3457	0.2868	0.0483	0.2943	0.2303	0.0422
Districts	Sargodha	0.3507	0.265	0.073	0.3466	0.2364	0.0869	0.2963	0.2061	0.0751	0.3065	0.2185	0.072	0.3653	0.2886	0.0843	0.3286	0.2543	0.0864	0.3298	0.2531	0.0846
PROVINCE	Sind	0.2134	0.174	0.0322	0.1984	0.1563	0.0288	0.2143	0.1757	0.0302	0.2113	0.174	0.0289	0.2266	0.1856	0.032	0.2201	0.1742	0.0337	0.2098	0.167	0.0328
	Hyderabad	0.1877	0.1595	0.0216	0.1776	0.147	0.0215	0.188	0.1605	0.0207	0.1895	0.163	0.0208	0.2006	0.1707	0.0224	0.2014	0.1686	0.0243	0.186	0.1545	0.0221
	Karachi	0.1453	0.1228	0.0136	0.1369	0.1166	0.0139	0.1506	0.1294	0.0161	0.1466	0.1269	0.0121	0.1517	0.1328	0.0136	0.1434	0.1257	0.0126	0.1298	0.1146	0.0107
	Larkana	0.3323	0.2698	0.0547	0.3093	0.2348	0.0504	0.3018	0.2446	0.0447	0.3009	0.25	0.0401	0.3387	0.2725	0.0496	0.3402	0.256	0.0531	0.3366	0.2632	0.0579
	Mirpur Khas	0.201	0.1624	0.0302	0.182	0.141	0.0263	0.2205	0.1796	0.0332	0.2147	0.1654	0.0338	0.2163	0.173	0.033	0.1996	0.1549	0.0324	0.1851	0.1462	0.0301
	Rann of Kutch	0.2592	0.2177	0.0394	0.2481	0.1998	0.0361	0.2379	0.1824	0.0475	0.2492	0.211	0.0314	0.2775	0.2168	0.0643	0.2659	0.1938	0.0554	0.2822	0.199	0.0492
Districts	Sukkur	0.2137	0.1674	0.0405	0.1997	0.1533	0.0331	0.2097	0.1653	0.0345	0.2022	0.1679	0.0311	0.229	0.1847	0.0377	0.2202	0.1701	0.0408	0.2187	0.1677	0.0409

		NDVI DURING RABI SEASON																							
YEAR		1989			1990			1991			1992			1993			1994			1995			1996		
		MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD
PROVIN	Azad Kashmir	0.2825	0.2221	0.0699	0.3387	0.2596	0.0751	0.3135	0.2327	0.0784	0.2945	0.2285	0.0732	0.3296	0.2266	0.0898	0.3227	0.2033	0.0942	0.3173	0.2474	0.0676	0.3545	0.2623	0.0593
PROVIN	Balochistan	0.0849	0.0781	0.0072	0.089	0.0806	0.0052	0.0885	0.0797	0.0057	0.0874	0.0787	0.0058	0.0889	0.0792	0.0072	0.0915	0.0809	0.0067	0.0902	0.0829	0.0065	0.0929	0.0826	0.0067
	Kalat	0.084	0.0782	0.006	0.0867	0.0804	0.0038	0.0862	0.0795	0.0042	0.0844	0.0769	0.0046	0.0876	0.0789	0.0057	0.0866	0.0785	0.0045	0.0914	0.0852	0.0055	0.0927	0.0834	0.0055
	Makran	0.0376	0.0354	0.0018	0.0377	0.0349	0.0016	0.0383	0.0353	0.0017	0.0376	0.0356	0.0017	0.0381	0.0353	0.002	0.0384	0.0355	0.0018	0.0376	0.0356	0.0017	0.0393	0.0364	0.0021
	Nasirabad	0.1544	0.1236	0.0255	0.1614	0.1296	0.0277	0.1577	0.1311	0.0259	0.1615	0.1261	0.0279	0.1594	0.1307	0.0273	0.1698	0.1382	0.0259	0.1674	0.1358	0.0268	0.1657	0.1414	0.0246
	Quetta	0.0709	0.066	0.0059	0.0756	0.0687	0.004	0.0768	0.0679	0.0051	0.0747	0.0683	0.0041	0.0779	0.0678	0.0078	0.079	0.0694	0.0062	0.0727	0.0683	0.0051	0.0839	0.0701	0.0074
	Sibi	0.128	0.1191	0.0091	0.1335	0.1216	0.0066	0.1298	0.1185	0.0071	0.1315	0.1185	0.008	0.1298	0.1184	0.0077	0.1379	0.1225	0.0094	0.1327	0.1229	0.0092	0.1305	0.1186	0.008
Districts	Zhob	0.1103	0.1028	0.011	0.1205	0.1081	0.0061	0.1195	0.1061	0.0075	0.1177	0.1074	0.0065	0.1163	0.1044	0.0089	0.1282	0.1108	0.011	0.1179	0.1076	0.0078	0.1192	0.1077	0.0073
PROVIN	F.A.T.A	0.2256	0.1947	0.0285	0.2531	0.2122	0.0333	0.2403	0.2051	0.0293	0.2422	0.1982	0.0324	0.2442	0.2031	0.0285	0.2548	0.1998	0.0423	0.2469	0.2138	0.0307	0.2667	0.2172	0.0316
PROVIN	F.C.T/ ISLAMABAD	0.4453	0.3923	0.0816	0.4583	0.4181	0.0576	0.4569	0.3965	0.0984	0.4369	0.3847	0.0945	0.4434	0.3311	0.0976	0.4392	0.3384	0.1332	0.472	0.4204	0.0767	0.4731	0.4145	0.0535
PROVIN	N.W.F.P./Khyber-Pakhtunwala	0.2304	0.1788	0.0455	0.2654	0.2078	0.0472	0.2475	0.1949	0.046	0.2469	0.1896	0.0447	0.2557	0.1926	0.0467	0.2633	0.1901	0.0553	0.2547	0.2066	0.0424	0.2683	0.2046	0.0454
	Bannu	0.2171	0.1804	0.0314	0.2631	0.2098	0.0381	0.2517	0.2076	0.0371	0.2509	0.203	0.0452	0.2259	0.19	0.0331	0.245	0.1891	0.0436	0.2408	0.2001	0.0386	0.231	0.1804	0.0355
	Dera Ismail Khan	0.2179	0.1841	0.0373	0.2402	0.193	0.0412	0.2291	0.1883	0.0347	0.2186	0.1745	0.0376	0.2243	0.1854	0.0331	0.2269	0.1804	0.0355	0.2348	0.1881	0.0378	0.243	0.2048	0.0377
	Hazara	0.2452	0.18	0.0522	0.2854	0.2143	0.0617	0.2599	0.192	0.0526	0.2486	0.1881	0.0495	0.2782	0.1953	0.0549	0.2828	0.1964	0.0681	0.2663	0.2111	0.0518	0.2915	0.2077	0.0495
	Kohat	0.2567	0.2305	0.025	0.2839	0.244	0.0256	0.2877	0.2486	0.028	0.279	0.2334	0.0322	0.2637	0.2329	0.0235	0.2814	0.2228	0.0344	0.2791	0.2464	0.0239	0.2823	0.2355	0.0273
	Malakand	0.1584	0.1148	0.0331	0.1886	0.1317	0.0416	0.1665	0.1207	0.037	0.1701	0.1193	0.0336	0.191	0.129	0.0423	0.1972	0.122	0.0462	0.1756	0.1338	0.0367	0.1958	0.1345	0.0395
	Mardan	0.4395	0.3258	0.1133	0.5091	0.4364	0.0829	0.4783	0.3939	0.1101	0.5073	0.3937	0.0926	0.4846	0.3866	0.0946	0.486	0.3829	0.1132	0.5218	0.4304	0.0765	0.5104	0.4291	0.0877
Districts	Peshawar	0.4003	0.3141	0.0972	0.4455	0.3889	0.0529	0.438	0.3712	0.079	0.4522	0.3647	0.085	0.4211	0.3274	0.0788	0.4392	0.3573	0.0963	0.4484	0.3893	0.0552	0.4551	0.3643	0.0876
PROVIN	Northern Areas- Gilgit Baltistan	0.0422	0.0289	0.0077	0.0443	0.0274	0.0074	0.0411	0.0262	0.0068	0.0373	0.0252	0.006	0.0517	0.0298	0.0099	0.0738	0.0356	0.0174	0.0403	0.0267	0.0069	0.0475	0.0269	0.0092
PROVIN	Punjab	0.3838	0.3116	0.0776	0.4168	0.3344	0.0771	0.3954	0.3065	0.0888	0.4015	0.3109	0.0977	0.3959	0.3176	0.0791	0.4003	0.2975	0.0933	0.421	0.3392	0.0901	0.4265	0.3606	0.0894
	Bahawalpur	0.2682	0.225	0.0497	0.2896	0.2236	0.052	0.269	0.2116	0.0478	0.2768	0.2165	0.0519	0.29	0.2344	0.0481	0.3012	0.2355	0.0527	0.3082	0.2419	0.0579	0.3122	0.2544	0.0575
	Dera Ghazi Khan	0.2595	0.2145	0.047	0.2871	0.2272	0.0501	0.2654	0.2128	0.0481	0.2819	0.2198	0.0493	0.2769	0.22	0.0497	0.2898	0.2179	0.0574	0.2907	0.2249	0.0557	0.3	0.2511	0.0603
	Faisalabad	0.5187	0.434	0.1023	0.5641	0.4606	0.1081	0.5174	0.4052	0.1384	0.5261	0.4281	0.1609	0.517	0.409	0.111	0.53	0.3886	0.1382	0.5505	0.4496	0.1379	0.5566	0.4819	0.1525
	Gujranwala	0.5788	0.4253	0.1506	0.6186	0.5158	0.1132	0.5781	0.4197	0.1757	0.5934	0.4216	0.1952	0.5793	0.4405	0.1571	0.5613	0.3988	0.1644	0.6241	0.5273	0.1318	0.6139	0.5218	0.1354
	Lahore	0.5924	0.4712	0.145	0.6095	0.4869	0.1386	0.5837	0.4167	0.1794	0.5841	0.3958	0.2078	0.5704	0.445	0.1311	0.5807	0.4156	0.1624	0.6232	0.4962	0.1683	0.6159	0.5227	0.1444
	Multan	0.5546	0.424	0.1294	0.5878	0.4572	0.1214	0.5545	0.4239	0.1277	0.5901	0.4691	0.1272	0.5745	0.4688	0.1146	0.5934	0.42	0.163	0.6211	0.4841	0.1606	0.6172	0.531	0.1456
	Rawalpindi	0.3097	0.2736	0.0364	0.3508	0.2953	0.0486	0.3579	0.3009	0.045	0.3367	0.2805	0.0508	0.3298	0.2896	0.0411	0.3019	0.2404	0.0491	0.3395	0.2909	0.0425	0.3612	0.3075	0.0438
Districts	Sargodha	0.3355	0.2846	0.0553	0.3853	0.3111	0.0642	0.3811	0.3031	0.0753	0.3635	0.2945	0.0865	0.3482	0.2796	0.0722	0.3499	0.2661	0.0743	0.3612	0.2971	0.0699	0.3756	0.3175	0.0712
PROVIN	Sind	0.2302	0.1968	0.0357	0.2351	0.1941	0.0347	0.2329	0.1887	0.0338	0.2213	0.1769	0.0329	0.2409	0.1945	0.0357	0.2341	0.1924	0.0319	0.2532	0.2062	0.0384	0.2408	0.2006	0.0343
	Hyderabad	0.2042	0.1763	0.026	0.2078	0.1775	0.0238	0.2007	0.167	0.0227	0.1928	0.1622	0.0217	0.2111	0.1767	0.0253	0.199	0.1678	0.0222	0.2111	0.1809	0.0256	0.2125	0.1819	0.0238
	Karachi	0.1548	0.1327	0.0165	0.1588	0.1312	0.0143	0.1608	0.1318	0.0166	0.1391	0.1244	0.0108	0.1708	0.1401	0.0192	0.1518	0.1286	0.0128	0.1817	0.154	0.0213	0.1676	0.1435	0.0157
	Larkana	0.3293	0.2733	0.0544	0.3622	0.2865	0.0612	0.341	0.2756	0.0549	0.3375	0.2604	0.0558	0.3347	0.2732	0.0554	0.3681	0.2833	0.0566	0.3522	0.2669	0.0588	0.3543	0.2903	0.058
	Mirpur Khas	0.2331	0.2019	0.0413	0.2184	0.1782	0.0343	0.2376	0.1864	0.0355	0.2056	0.1619	0.0314	0.2481	0.1898	0.0387	0.2248	0.1881	0.0296	0.2713	0.2216	0.0413	0.2287	0.1858	0.0324
	Rann of Kutch	0.2995	0.2259	0.0613	0.3382	0.2647	0.0761	0.2954	0.2317	0.0595	0.3099	0.2163	0.0861	0.3197	0.2495	0.0599	0.3522	0.288	0.0578	0.394	0.2762	0.118	0.4037	0.3137	0.0957
Districts	Sukkur	0.224	0.1902	0.0361	0.2389	0.1974	0.0395	0.229	0.1862	0.039	0.2317	0.1798	0.0412	0.2372	0.1927	0.0389	0.2378	0.1945	0.038	0.2513	0.2009	0.0442	0.2464	0.2061	0.041

NDVI During *Rabi* Season Data (Max, Median and Standard Deviation) continued

		NDVI DURING RABI SEASON																	
YEAR		1997			1998			1999			2000			2001			2002		
		MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD
PROVIN	Azad Kashmir	0.3464	0.2592	0.0613	0.3493	0.2719	0.0471	0.3778	0.2488	0.0796	0.3503	0.2417	0.0872	0.3558	0.2656	0.0559	0.3584	0.2492	0.0595
PROVIN	Balochistan	0.0889	0.0805	0.006	0.0933	0.0836	0.0059	0.0916	0.0821	0.0065	0.0876	0.0797	0.0054	0.1005	0.0917	0.0078	0.1002	0.0886	0.0087
	Kalat	0.0896	0.0806	0.0056	0.0904	0.0833	0.0045	0.0894	0.0812	0.0054	0.0842	0.0774	0.0042	0.0986	0.0902	0.0071	0.098	0.0866	0.0074
	Makran	0.0382	0.0358	0.0022	0.0403	0.0374	0.0019	0.0391	0.0366	0.0018	0.0381	0.0355	0.0017	0.0812	0.0739	0.007	0.0775	0.0697	0.0063
	Nasirabad	0.1548	0.1274	0.0197	0.1656	0.133	0.0243	0.1676	0.1367	0.0269	0.1701	0.1389	0.0253	0.1738	0.1448	0.0301	0.1799	0.143	0.0321
	Quetta	0.0759	0.0691	0.0054	0.0802	0.0726	0.0045	0.0785	0.0709	0.0051	0.0754	0.0686	0.0047	0.075	0.0705	0.0037	0.0753	0.0681	0.0053
	Sibi	0.1294	0.1203	0.0062	0.1367	0.1238	0.0077	0.1328	0.1199	0.008	0.1312	0.1207	0.0066	0.1316	0.1192	0.009	0.1313	0.1176	0.0101
Districts	Zhob	0.1156	0.1065	0.0073	0.1286	0.1115	0.0089	0.1247	0.1102	0.0087	0.1155	0.1066	0.0064	0.118	0.1099	0.0076	0.1193	0.1072	0.0104
PROVIN	F.A.T.A	0.2426	0.2048	0.032	0.2699	0.225	0.0302	0.2698	0.2153	0.0353	0.2593	0.2128	0.039	0.259	0.2201	0.0321	0.2751	0.2156	0.0359
PROVIN	F.C.T/ ISLAMABAD	0.4255	0.3891	0.0423	0.4664	0.4317	0.0243	0.4644	0.3987	0.1041	0.4533	0.3688	0.1076	0.393	0.3502	0.0581	0.4145	0.3663	0.0475
PROVIN	N.W.F.P./Khyber-Pakhtunwala	0.2609	0.1992	0.0427	0.2759	0.2134	0.0378	0.2913	0.2037	0.053	0.279	0.2051	0.0525	0.2721	0.2098	0.0434	0.2787	0.2033	0.046
	Bannu	0.2079	0.1631	0.0381	0.2574	0.2129	0.0311	0.2636	0.2091	0.0453	0.2417	0.194	0.0434	0.2506	0.1717	0.0595	0.2187	0.1502	0.0411
	Dera Ismail Khan	0.2174	0.1806	0.0346	0.2543	0.2086	0.0327	0.2557	0.2089	0.0367	0.2391	0.1963	0.0373	0.2461	0.2016	0.0447	0.2407	0.1981	0.0425
	Hazara	0.3092	0.2196	0.0554	0.2964	0.2107	0.0473	0.3426	0.2031	0.0711	0.309	0.208	0.0651	0.3056	0.2222	0.049	0.311	0.2086	0.053
	Kohat	0.2487	0.2183	0.0198	0.3018	0.2664	0.0228	0.3005	0.2503	0.0319	0.2777	0.2365	0.0301	0.2709	0.232	0.0302	0.2647	0.2297	0.0223
	Malakand	0.1959	0.1337	0.0357	0.2003	0.1337	0.0371	0.2156	0.1262	0.0442	0.2202	0.1377	0.0451	0.2087	0.1471	0.0344	0.2197	0.1391	0.0419
	Mardan	0.4846	0.4093	0.0733	0.5109	0.4468	0.0481	0.5017	0.4063	0.1011	0.498	0.4143	0.1054	0.4691	0.408	0.0683	0.5204	0.43	0.0759
Districts	Peshawar	0.4192	0.349	0.0733	0.4506	0.3999	0.0416	0.4469	0.3861	0.0695	0.4448	0.3785	0.0827	0.4219	0.3644	0.061	0.4454	0.3659	0.0731
PROVIN	Northern Areas- Gilgit Baltista	0.066	0.0399	0.0139	0.0511	0.0287	0.0101	0.0699	0.0293	0.0164	0.0715	0.036	0.0158	0.0633	0.0384	0.012	0.0475	0.026	0.0093
PROVIN	Punjab	0.3984	0.3245	0.0723	0.419	0.3438	0.063	0.4289	0.326	0.0922	0.4224	0.3365	0.0963	0.4344	0.3498	0.0797	0.4255	0.3296	0.0941
	Bahawalpur	0.2903	0.2368	0.044	0.3016	0.2366	0.0446	0.3101	0.2334	0.0601	0.3049	0.2521	0.0506	0.3115	0.2393	0.0614	0.3056	0.2323	0.0668
	Dera Ghazi Khan	0.2715	0.2183	0.0423	0.2986	0.2317	0.0494	0.303	0.2281	0.0619	0.3003	0.2497	0.0577	0.327	0.2461	0.0633	0.3122	0.2314	0.0672
	Faisalabad	0.5262	0.4343	0.104	0.5386	0.4525	0.0714	0.5322	0.4037	0.1284	0.5425	0.4031	0.1479	0.5611	0.4667	0.0909	0.5529	0.4363	0.1268
	Gujranwala	0.5867	0.4627	0.121	0.592	0.5019	0.0897	0.6381	0.4884	0.1404	0.6193	0.4983	0.1784	0.6114	0.5125	0.1184	0.6278	0.48	0.1378
	Lahore	0.6002	0.5007	0.1253	0.5955	0.5002	0.094	0.6295	0.4832	0.1423	0.6175	0.4997	0.1659	0.6395	0.5464	0.1182	0.6333	0.49	0.1592
	Multan	0.5916	0.4699	0.1272	0.6078	0.4875	0.1159	0.6147	0.426	0.1721	0.6224	0.4857	0.1473	0.6644	0.5389	0.1189	0.6361	0.5098	0.1547
	Rawalpindi	0.3168	0.2759	0.0339	0.3714	0.3241	0.0337	0.3734	0.3079	0.0529	0.3606	0.2902	0.0624	0.3086	0.2609	0.0432	0.3134	0.2612	0.0394
Districts	Sargodha	0.3425	0.2767	0.0649	0.375	0.3134	0.053	0.3767	0.302	0.0716	0.3565	0.2708	0.0839	0.3882	0.3011	0.0765	0.3681	0.2775	0.085
PROVIN	Sind	0.2294	0.1922	0.0313	0.234	0.1909	0.033	0.2497	0.2026	0.0377	0.2364	0.1943	0.035	0.2396	0.1897	0.0412	0.2389	0.187	0.0425
	Hyderabad	0.2058	0.1763	0.024	0.2063	0.1754	0.0223	0.2111	0.1777	0.0248	0.2006	0.1696	0.0248	0.2168	0.1762	0.0309	0.2079	0.1714	0.03
	Karachi	0.1539	0.1353	0.0166	0.1547	0.1358	0.0123	0.15	0.1296	0.0122	0.1425	0.1238	0.0128	0.148	0.1203	0.0189	0.1533	0.1238	0.0227
	Larkana	0.3356	0.269	0.0448	0.3478	0.2641	0.0545	0.3916	0.2949	0.0711	0.38	0.3033	0.0671	0.3467	0.279	0.0579	0.3819	0.2834	0.0724
	Mirpur Khas	0.2114	0.1802	0.031	0.2205	0.1796	0.0348	0.2434	0.2041	0.0344	0.2179	0.1748	0.0325	0.2146	0.1603	0.0419	0.206	0.1608	0.0368
	Rann of Kutch	0.3628	0.2884	0.0594	0.3994	0.2994	0.0631	0.3915	0.3156	0.0894	0.3793	0.3056	0.0735	0.381	0.2726	0.071	0.3804	0.2375	0.1002
Districts	Sukkur	0.2388	0.1969	0.0365	0.241	0.1956	0.0375	0.253	0.1989	0.0459	0.2477	0.2055	0.0391	0.2568	0.2058	0.049	0.2587	0.1988	0.0536

	NDVI DURING RABI SEASON																				
	2003			2004			2005			2006			2007			2008			2009		
	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD
Azad Kashmir	0.3371	0.2475	0.0755	0.3711	0.2687	0.1036	0.3606	0.2685	0.0748	0.3759	0.2643	0.0685	0.4139	0.2906	0.0673	0.3606	0.2339	0.082	0.3586	0.286	0.0453
Balochistan	0.0967	0.0876	0.008	0.0863	0.0769	0.0111	0.0891	0.0749	0.0131	0.0976	0.0821	0.0094	0.1079	0.0867	0.0128	0.1025	0.0863	0.0132	0.1057	0.0888	0.0103
Kalat	0.0922	0.0849	0.0069	0.0856	0.0786	0.01	0.0868	0.0757	0.0109	0.0948	0.0813	0.0082	0.1076	0.0898	0.0112	0.1069	0.0896	0.0133	0.1073	0.0904	0.0094
Makran	0.0752	0.0683	0.0084	0.0385	0.0354	0.0065	0.0391	0.0333	0.0083	0.0447	0.0374	0.0045	0.0426	0.0367	0.0045	0.0491	0.0407	0.0095	0.0473	0.0397	0.0041
Nasirabad	0.173	0.1447	0.0278	0.1769	0.129	0.0391	0.166	0.138	0.0309	0.1824	0.1323	0.0316	0.1999	0.1444	0.0417	0.1929	0.1483	0.0376	0.1969	0.1439	0.0381
Quetta	0.0736	0.0672	0.0052	0.0649	0.0575	0.0115	0.0738	0.0529	0.0171	0.08	0.0631	0.0106	0.0795	0.0596	0.0108	0.0756	0.0623	0.0125	0.0846	0.074	0.0084
Sibi	0.1262	0.1168	0.007	0.1291	0.1178	0.0103	0.1315	0.1164	0.0133	0.1446	0.1265	0.0103	0.157	0.1343	0.0145	0.1445	0.1276	0.011	0.1551	0.1333	0.0131
Zhob	0.1207	0.1077	0.0076	0.1144	0.1037	0.0091	0.1213	0.1029	0.0131	0.1325	0.1172	0.0086	0.1599	0.1234	0.0182	0.1302	0.1147	0.0109	0.1351	0.1144	0.011
F.A.T.A	0.2668	0.2191	0.0337	0.2556	0.2138	0.0386	0.2655	0.2072	0.0444	0.2857	0.233	0.0347	0.3184	0.2422	0.0459	0.2812	0.2253	0.0359	0.2803	0.2375	0.0298
F.C.T/ ISLAMABAD	0.509	0.4365	0.056	0.5195	0.4531	0.1373	0.5417	0.4652	0.0654	0.4751	0.3987	0.0715	0.5725	0.4789	0.0915	0.4985	0.4074	0.0787	0.501	0.4538	0.0489
N.W.F.P./Khyber-Pakhtunwala	0.271	0.2049	0.0484	0.2837	0.2106	0.0695	0.2761	0.2148	0.0427	0.2922	0.2151	0.0505	0.3238	0.229	0.0586	0.2829	0.1978	0.0514	0.2761	0.2176	0.0454
Bannu	0.297	0.2327	0.0473	0.2667	0.1936	0.0655	0.2894	0.2269	0.0408	0.2389	0.1845	0.0413	0.3392	0.2564	0.0654	0.2607	0.223	0.0404	0.2471	0.1967	0.039
Dera Ismail Khan	0.2475	0.2041	0.0389	0.2672	0.2031	0.0634	0.2776	0.2326	0.0359	0.2604	0.2044	0.042	0.3135	0.2628	0.0502	0.2437	0.1993	0.0461	0.2577	0.2144	0.0376
Hazara	0.2842	0.1941	0.0596	0.3028	0.2123	0.0844	0.2812	0.2083	0.0549	0.311	0.214	0.0606	0.3358	0.2201	0.0645	0.3	0.1919	0.0581	0.2852	0.2209	0.0432
Kohat	0.2957	0.2486	0.032	0.2837	0.2353	0.0398	0.3209	0.2634	0.0383	0.2958	0.2506	0.0294	0.3736	0.2911	0.0603	0.3161	0.2673	0.0353	0.3014	0.2592	0.0279
Malakand	0.1895	0.1283	0.0448	0.2086	0.1385	0.0474	0.182	0.1252	0.0362	0.2275	0.146	0.0467	0.2235	0.1315	0.0462	0.2144	0.1162	0.0477	0.1909	0.1315	0.0388
Mardan	0.5233	0.4355	0.0717	0.5431	0.4495	0.1695	0.5449	0.47	0.0537	0.5617	0.4545	0.0898	0.6118	0.4816	0.0927	0.5195	0.4058	0.0929	0.5645	0.4765	0.1035
Peshawar	0.4564	0.3867	0.0566	0.4741	0.3964	0.1171	0.4834	0.4102	0.0503	0.4655	0.3919	0.0631	0.5292	0.3942	0.0946	0.4491	0.359	0.0595	0.4922	0.4196	0.0926
Northern Areas- Gilgit Baltistai	0.0491	0.0264	0.0106	0.0371	0.0191	0.0085	0.0291	0.0144	0.0082	0.0448	0.0239	0.0095	0.0609	0.0237	0.0155	0.0501	0.0263	0.0106	0.0317	0.014	0.0079
Punjab	0.4353	0.3532	0.0887	0.455	0.3539	0.1271	0.476	0.3838	0.0717	0.4424	0.3346	0.0799	0.4865	0.381	0.1018	0.4157	0.3506	0.0741	0.4595	0.3714	0.0904
Bahawalpur	0.2978	0.2358	0.0555	0.3234	0.2528	0.0819	0.3207	0.254	0.0572	0.31	0.2293	0.0666	0.3271	0.255	0.0682	0.3018	0.2483	0.062	0.332	0.2563	0.0716
Dera Ghazi Khan	0.3156	0.2496	0.0572	0.3052	0.2287	0.082	0.3343	0.2703	0.0542	0.324	0.2347	0.0607	0.352	0.2752	0.0751	0.3078	0.245	0.0545	0.3437	0.2696	0.0673
Faisalabad	0.549	0.4718	0.1045	0.5817	0.4626	0.18	0.6141	0.504	0.0802	0.5847	0.4383	0.0944	0.6107	0.4766	0.1357	0.5219	0.4492	0.0878	0.578	0.4815	0.1048
Gujranwala	0.6072	0.4919	0.1661	0.6794	0.5118	0.2253	0.6888	0.5641	0.0942	0.6583	0.5063	0.1284	0.7046	0.5588	0.1598	0.6067	0.5191	0.1245	0.6838	0.5555	0.1471
Lahore	0.6028	0.4926	0.1806	0.6628	0.5236	0.1896	0.6633	0.5588	0.0964	0.6434	0.5009	0.1174	0.6782	0.5419	0.1418	0.6006	0.5335	0.1117	0.6583	0.5588	0.1333
Multan	0.6168	0.4978	0.1275	0.6743	0.5382	0.1725	0.6931	0.5493	0.1069	0.6546	0.4731	0.1217	0.6635	0.5273	0.1303	0.5681	0.4813	0.0835	0.6352	0.5084	0.1488
Rawalpindi	0.3599	0.3029	0.0389	0.4009	0.3255	0.0937	0.4179	0.3478	0.0482	0.3499	0.2934	0.0414	0.4606	0.3753	0.0646	0.3804	0.3177	0.0507	0.4018	0.3343	0.0506
Sargodha	0.4628	0.3682	0.0825	0.4009	0.2995	0.1209	0.4659	0.3551	0.0771	0.3809	0.2934	0.0635	0.4813	0.3511	0.1189	0.3589	0.308	0.0697	0.3981	0.322	0.0682
Sind	0.235	0.182	0.0398	0.251	0.1954	0.0569	0.237	0.1897	0.043	0.2434	0.1859	0.0472	0.2685	0.2102	0.0494	0.2565	0.2047	0.0503	0.2516	0.1884	0.0516
Hyderabad	0.2141	0.1696	0.0322	0.2129	0.1737	0.0395	0.2156	0.1746	0.035	0.2181	0.1751	0.0377	0.2416	0.1986	0.0361	0.2398	0.1944	0.0417	0.2356	0.1863	0.0391
Karachi	0.1389	0.1103	0.0213	0.1462	0.1278	0.02	0.1447	0.1145	0.0225	0.168	0.1281	0.0247	0.1808	0.1487	0.018	0.1962	0.1568	0.0283	0.1803	0.1548	0.0164
Larkana	0.3742	0.2878	0.0646	0.3805	0.2799	0.0887	0.3876	0.3127	0.0616	0.3815	0.2698	0.0655	0.4226	0.3114	0.0777	0.3856	0.297	0.072	0.3619	0.2627	0.0715
Mirpur Khas	0.1894	0.1434	0.031	0.2485	0.1965	0.0564	0.1969	0.1531	0.0396	0.2137	0.1627	0.044	0.2385	0.1796	0.0473	0.226	0.1869	0.0466	0.2136	0.1662	0.0448
Rann of Kutch	0.335	0.236	0.0798	0.3029	0.2038	0.0828	0.3499	0.2607	0.0855	0.4149	0.3286	0.1031	0.4639	0.3608	0.1176	0.4428	0.3282	0.119	0.4309	0.2857	0.1333
Sukkur	0.2584	0.1993	0.0501	0.2565	0.1917	0.0703	0.2494	0.2007	0.0507	0.253	0.192	0.057	0.2745	0.2179	0.0595	0.2579	0.1994	0.0577	0.2698	0.1839	0.0701

		NDVI DURING RABI SEASON																	
YEAR		2010			2011			2012			2013			2014			2015		
		MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD	MAX	MEDIAN	STD
PROVIN	Azad Kashmir	0.3782	0.2568	0.0869	0.3762	0.2706	0.0558	0.3303	0.255	0.0451	0.371	0.2843	0.0632	0.3553	0.2588	0.0507	0.3898	0.2754	0.0691
PROVIN	Balochistan	0.0993	0.0864	0.0095	0.1124	0.0934	0.0108	0.1154	0.1038	0.0099	0.1113	0.0987	0.0072	0.1077	0.0975	0.0059	0.1054	0.0948	0.0068
	Kalat	0.094	0.0844	0.0083	0.11	0.0923	0.0099	0.114	0.1032	0.0098	0.1045	0.0958	0.0053	0.1033	0.0953	0.0041	0.0993	0.0916	0.0048
	Makran	0.0444	0.0385	0.0034	0.0558	0.0414	0.0074	0.0868	0.0787	0.0069	0.0812	0.0746	0.0046	0.0839	0.0756	0.0055	0.08	0.0737	0.0044
	Nasirabad	0.2016	0.1473	0.0417	0.2402	0.1808	0.04	0.2317	0.1739	0.0451	0.2253	0.1708	0.0389	0.201	0.167	0.0291	0.2049	0.1706	0.0359
	Quetta	0.0823	0.0726	0.008	0.0814	0.071	0.0078	0.0789	0.0743	0.0033	0.0774	0.0711	0.0029	0.0768	0.0714	0.0027	0.0749	0.0704	0.0024
	Sibi	0.15	0.1303	0.011	0.1665	0.1457	0.011	0.1604	0.146	0.014	0.1623	0.1428	0.0099	0.1464	0.1342	0.0072	0.1429	0.1269	0.0089
Districts	Zhob	0.1344	0.118	0.0097	0.1484	0.1244	0.0108	0.133	0.1243	0.0077	0.141	0.1205	0.0083	0.1335	0.1174	0.0071	0.1355	0.1152	0.0093
PROVIN	F.A.T.A	0.2844	0.2313	0.0366	0.3106	0.2477	0.0375	0.2796	0.2435	0.03	0.3128	0.2544	0.0386	0.3021	0.2487	0.0313	0.3103	0.2374	0.045
PROVIN	F.C.T/ ISLAMABAD	0.478	0.3566	0.1072	0.5005	0.4281	0.0477	0.4522	0.3978	0.0612	0.5285	0.4538	0.08	0.4706	0.4129	0.0339	0.5067	0.4058	0.0734
PROVIN	N.W.F.P./Khyber-Pakh	0.2845	0.2003	0.0606	0.3099	0.2145	0.0538	0.2666	0.2101	0.0383	0.2931	0.2256	0.0453	0.2825	0.2203	0.0382	0.3027	0.2189	0.0538
	Bannu	0.2464	0.1898	0.0441	0.2822	0.2168	0.0478	0.2634	0.2257	0.034	0.3166	0.2624	0.0449	0.2895	0.2513	0.0371	0.3049	0.237	0.0468
	Dera Ismail Khan	0.2645	0.2125	0.0427	0.2995	0.2431	0.0412	0.2626	0.2269	0.0306	0.2884	0.2485	0.0287	0.2637	0.2295	0.0294	0.2568	0.2153	0.0346
	Hazara	0.3067	0.202	0.0744	0.3267	0.204	0.0597	0.2806	0.2028	0.0429	0.2982	0.2134	0.05	0.293	0.2092	0.0424	0.3261	0.2213	0.0576
	Kohat	0.2827	0.2359	0.0307	0.3312	0.2831	0.0317	0.301	0.2705	0.0295	0.3516	0.2948	0.0388	0.3317	0.2908	0.0246	0.3365	0.2732	0.0402
	Malakand	0.2127	0.131	0.0532	0.228	0.1236	0.0485	0.1857	0.1258	0.0314	0.1968	0.13	0.0366	0.192	0.1323	0.0303	0.2192	0.1398	0.0436
	Mardan	0.5374	0.3919	0.1188	0.5632	0.4375	0.0955	0.4969	0.428	0.0759	0.5479	0.4592	0.0862	0.5373	0.4446	0.07	0.558	0.4199	0.1193
Districts	Peshawar	0.4761	0.343	0.1066	0.5007	0.3977	0.1004	0.4218	0.3677	0.064	0.4872	0.4068	0.0896	0.4816	0.3968	0.0875	0.5003	0.3837	0.1107
PROVIN	Northern Areas- Gilgit	0.0417	0.0205	0.0111	0.0586	0.0219	0.016	0.0519	0.0333	0.0087	0.0458	0.032	0.0059	0.046	0.0327	0.0058	0.0506	0.0334	0.0077
PROVIN	Punjab	0.4651	0.3545	0.1146	0.486	0.381	0.1102	0.4386	0.366	0.069	0.49	0.3873	0.0874	0.4576	0.3819	0.0794	0.4548	0.3597	0.1078
	Bahawalpur	0.3263	0.2598	0.074	0.3563	0.2883	0.0702	0.3335	0.2785	0.059	0.3467	0.2793	0.0586	0.3267	0.2712	0.0578	0.3084	0.2472	0.0758
	Dera Ghazi Khan	0.365	0.2841	0.0836	0.3781	0.2983	0.078	0.3486	0.2778	0.0606	0.3706	0.2882	0.0623	0.3502	0.2852	0.0631	0.3368	0.2692	0.0804
	Faisalabad	0.6355	0.4706	0.1682	0.6112	0.4676	0.1782	0.5347	0.4427	0.0779	0.608	0.4781	0.1125	0.5655	0.469	0.1146	0.5571	0.4349	0.1492
	Gujranwala	0.6647	0.4662	0.1585	0.7134	0.5601	0.1627	0.6584	0.5496	0.1129	0.7131	0.5615	0.1493	0.6778	0.5732	0.1101	0.6759	0.5406	0.1411
	Lahore	0.685	0.5289	0.1865	0.6747	0.5338	0.1714	0.6214	0.5373	0.0941	0.671	0.538	0.1325	0.6228	0.5352	0.1064	0.6461	0.5012	0.1595
	Multan	0.6735	0.5436	0.2058	0.6295	0.4864	0.173	0.5565	0.4647	0.0795	0.6551	0.5157	0.117	0.6374	0.5214	0.1466	0.5999	0.4696	0.1859
	Rawalpindi	0.3312	0.2368	0.058	0.4135	0.3337	0.0519	0.3579	0.3085	0.0481	0.4295	0.3578	0.0614	0.3901	0.3374	0.0357	0.4245	0.3464	0.0593
Districts	Sargodha	0.4055	0.3025	0.0922	0.4542	0.3409	0.1041	0.3956	0.331	0.0566	0.4822	0.3643	0.0847	0.4238	0.3533	0.0607	0.4467	0.3449	0.0969
PROVIN	Sind	0.2587	0.1963	0.0519	0.2916	0.233	0.0484	0.2767	0.2259	0.048	0.281	0.2253	0.048	0.2602	0.217	0.0389	0.252	0.2023	0.0486
	Hyderabad	0.2366	0.1863	0.0405	0.2536	0.2109	0.0344	0.2489	0.2089	0.0367	0.2531	0.2105	0.0371	0.2318	0.1993	0.0292	0.2272	0.1874	0.0367
	Karachi	0.1805	0.1513	0.0191	0.198	0.1713	0.0158	0.1945	0.1707	0.022	0.1703	0.1556	0.0136	0.1612	0.1487	0.0092	0.1462	0.133	0.0094
	Larkana	0.3783	0.287	0.0714	0.4242	0.3299	0.086	0.3834	0.313	0.0692	0.4131	0.3176	0.0771	0.3927	0.3142	0.0679	0.3959	0.3031	0.0918
	Mirpur Khas	0.234	0.1756	0.0548	0.2587	0.2077	0.038	0.247	0.2032	0.0406	0.2448	0.193	0.0417	0.2286	0.1878	0.0337	0.2143	0.1658	0.0381
	Rann of Kutch	0.4445	0.2985	0.134	0.4946	0.4103	0.1142	0.448	0.3634	0.1165	0.4562	0.3629	0.1108	0.4121	0.3165	0.1047	0.3824	0.2843	0.1071
Districts	Sukkur	0.2673	0.1946	0.0579	0.3264	0.2508	0.0645	0.305	0.2383	0.0636	0.3076	0.2443	0.0592	0.2816	0.2343	0.0468	0.2706	0.2226	0.0597

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